THE NIAGARA SAND
AND GRAVEL STUDY

April, 1981

Regional Niagara
Planning and Development
Department

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Duncan Bury
Corwin Cambray
Paul Chapman
Ken Forgeron
Ed Murphy

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Chapter 1

NIAGARA'S SUPPLY AND DEMAND FOR SAND AND GRAVEL: AN OVERVIEW

Mineral aggregates are a basic component of construction activity in a community. Provincially, by far the largest amount of aggregates, over 50 percent of the annual production, is used for road construction and maintenance. In contrast, residential construction uses about 3 percent.

The demand for aggregates is related to changing economic conditions. From the 1940s into the 1970s, the demand for aggregates was pushed up by population growth, increasing highway construction, major building activities, and, in general, an expanding economy. One estimate suggests a five-fold increase in demand between 1945 and 1965. In the mid-1970s, Ontario used approximately 14 tons per capita of aggregate annually.

Mineral aggregates; sand, gravel and crushed stone; are obtained from pits and quarries licensed by the Ministry of Natural Resources. There are ten stone quarries and nine sand and gravel pits in the Niagara Region. Together they produced 5.6 million tons of aggregate in 1979. While crushed stone is produced from quarries spotted along either the Niagara Escarpment or the Onondaga Escarpment near Lake Erie, natural sand and gravel is extracted primarily from the Fonthill Kame. In 1979, about 823,600 tons or 88 percent of the sand and gravel produced from pits in Niagara came from Fonthill.

The possible resource areas for stone are considerably more extensive in the Region than those for sand and gravel. Conversely, within Ontario, the demand for sand and gravel is three times as great as the demand for crushed stone. Thus, there is a need to study Niagara's future supply and demand for sand and gravel.

The requirement for such a study was made more immediate by three possible applications for new or expanded pits on the Fonthill Kame. These applications raised questions of need, environmental concerns, and resource conflicts. Issues are perhaps perceived more keenly here due to the mix of natural features, residential and recreational uses, and tender fruit land contained in this relatively small area.

There have been previous mineral aggregate studies which included the Niagara Region. One example is the 1974 Mineral Aggregate Study of the Central Ontario Planning Region prepared for the Ministry of Natural Resources. This study lumps Niagara in with a much larger area which includes Metropolitan Toronto and surrounding area. There, the level of economic activity consumes 30 million tons of mineral aggregate per year. That picture needs adjustment in order to view Niagara's requirements.

In undertaking this study, information was assembled from a variety of sources. Besides reviewing a variety of publications listed in the bibliography (Appendix 2), three different questionnaires (Appendix 3) have been prepared and circulated in an effort to develop more detailed information on aggregate production and use. The questionnaires were sent to:

- the 12 local municipalities, Regional Niagara and seven adjacent municipalities in Haldimand-Norfolk and Hamilton-Wentworth. Completed questionnaires were received from all the municipalities.
- the 20 aggregate producers in Niagara. These questionnaires were followed by interviews with all the producers except one small operator who could not be reached.
- 24 aggregate users such as asphalt companies, building suppliers, etc. and 17 of these have been returned.

The Ministry of Natural Resources has provided assistance particularly on possible resource areas. Public input was sought and a public meeting was held on March 12, 1981. Information was obtained from a number of groups including the Niagara Regional Aggregate Haulers Associates, the Aggregate Producers Association, the Foundation for Aggregate Studies, the Ministry of Transportation and Communications, the St. Lawrence Seaway Authority, American and Canadian Customs officials, U.S. Corps of Engineers, New York State Departments, Centre for Inland Waters, General Motors, Stelco and other regional governments in Ontario.

Consultants were retained to provide assistance on the future demand for aggregates (Emrik H. Suichies and Associates) and on a generalized environmental framework (Ecoplans Ltd.). The results are presented as follows:

- Chapter 2 reviews the existing sand and gravel industry in Niagara by providing information on production, licensed areas, wayside pits, dredging, imports, exports and estimated licensed reserves.
- Chapter 3 looks at possible resource areas for sand and gravel outside of licensed areas through a series of 28 maps.
- Chapter 4 discusses possible alternatives for the present local supplies of sand and gravel, and the use of substitutes like slag, fly ash, and foundry sands. Importing sand and gravel is also considered.
- Chapter 5 considers the future demand for aggregates in Niagara.

- Chapter 6 presents a generalized environmental framework for assessing the suitability of possible aggregate areas for extraction. This framework then is applied to the Fonthill Kame.
- Chapter 7 concludes the study with a summary of the findings, a discussion of several policy issues and notes some unanswered questions.

While this study provides a much better understanding of Niagara's supply and demand for sand and gravel, there are no simple solutions. Economic, environmental, and social factors affect the supply and demand. The last two decades of the century will not mirror the middle part of this century. Thus, it would seem unlikely that the factors affecting the supply and demand for aggregate will remain unchanged. With uncertainty in a number of areas, sound resource management would suggest that some possible reserves of sand and gravel, a non-renewable natural resource, should remain available for possible use in the future if needed.

Chapter 2

CHARACTERISTICS OF THE SAND AND GRAVEL INDUSTRY IN NIAGARA

2.1 Introduction

Sand and gravel production in Niagara has increased substantially since the early 1900s. In 1918, eight operations located in Stamford (St. Davids), Fonthill, Lake Ontario and Lake Erie accounted for about 360,000 tons of sand and gravel. Dredging for sand represented the major portion (83%) of this production. In 1979, ten operations located in the St. Davids area, Fonthill, Port Colborne, Fort Erie and in Lake Ontario, accounted for over 1 million tons of sand and gravel or about three times the 1918 production level. The major portion (79%) of Niagara's 1979 production came from the three pits in Fonthill, whereas dredging accounted for only a small portion (11%) of the total production.

Chapter 2 describes the characteristics of Niagara's sand and gravel industry in the 1970s. To start, a brief overview of the origin and uses of sand and gravel is provided as an aid to understanding the topic. Section 2.3 sets out information on the production of sand and gravel both on a regional basis and for individual areas. Section 2.4 reviews the level of exporting and importing activity. Section 2.5 looks at the amount of reserves remaining within licensed pits.

Sources of information for this Chapter include the Ministry of Natural Resources and a Regional Niagara survey including both questionnaires and interviews. There are some dissimilarities between the production figures provided by the Ministry and those obtained from the survey. In 1972 for example apparently one major producer was overlooked in the Ministry's survey. Other data provided however reveals that the Region's survey of production was 4% to 8% higher than the Ministry of Natural Resources' information. In fact, the Ministry is aware that their statistics prior to 1977 may not be as reliable as data collected since that time due to less sophisticated recording methods and sampling techniques. The information gathered through the Regional survey of aggregate producers will be used for the purposes of this study.

The questionnaire to the aggregate producers in Niagara (see Appendix 3) requested information in the following areas:

. types and quantities of materials produced

. costs

. plant capacity

- markets
- transport of products
- amount of land and materials still available
- problems
- future of the industry

The data received have been assembled by geographical areas rather than by individual operation in order to protect the confidentiality of the information received from individual producers.

2.2 Sand and Gravel: Origin and Uses

Sand and gravel are unconsolidated deposits produced by the weathering of limestone, granite and other types of rock. Both the origin of a deposit and how it is transported affects the size and shape of the material in a sand and gravel deposit. There are four major types of deposits based upon how they were transported.

a) fluvial - by rivers and streams;

b) glacial - by the glaciers during an ice age;

c) lake and marine - by lakes or inland seas; and,

d) residual - a catch-all category for other deposits.

Materials deposited by rivers and streams are usually stratified or layered but not well sorted by size. Deposits left by glaciers during the Ice Age are generally not well sorted although some glacial features contain better sorted material than others. Deposits left by lakes and former seas offer the deposits which are best sorted in terms of texture (eg. coarse or fine). Residual deposits are a grouping of the remaining deposits and include a wide range of material and size.

Although a deposit may be called a sand and gravel deposit, it is not likely to be 100% sand and gravel. Deposits will contain other materials, known as deleterious materials, which may include clays, silts, shale and wood, which are removed in the processing of the material for sand and gravel products. The ultimate use to which deposits of sand and gravel can be put depends upon the combination of materials (eg. sand, gravel and silt), the size and shape of the aggregates and the chemical composition as well as demand.

In order to produce the products required, the sand and gravel found in the pit may be used in its unprocessed form or processed by screening, washing, and crushing. It is possible to estimate how much of a particular product could be produced from a sand and gravel deposit but normally a variety of products could be produced and the amount of each produced is dependent on the processing equipment available and the local demand. The processing may also include blending of materials from different parts of a pit to conform to a required standard or specification. For many uses, there are specifications developed by the Ministry of Transportation and Communications or other authorities which must be met. If a particular product is being produced, other materials which do not meet the specification for the required product would then be removed and can often be used to produce other products.

As shown in "A User's Guide to Construction Aggregate" which is presented in Appendix 5, aggregate can be divided into five groups:

1) Granular Base and Sub-Base,
2) Coarse Aggregate,
3) Fine Aggregate,
4) Clear Aggregate, and
5) Special Application.

Of particular significance to the discussion of sand and gravel are the first three groups.

Granular products are used in road construction for road bases and sub-bases and also for fill in trenches in many municipal sewer and water projects. Coarse Aggregate is used as input to Portland Cement Concrete, asphaltic concrete, and surface treatments. Fine Aggregates are used in all of the products requiring Coarse Aggregate as well as concrete blocks, masonry mortar and ice control. For some finished products both Fine and Coarse Aggregates are required. In Niagara this often results in materials from pits, dredging and quarries being combined to produce a finished product. Very fine sands and uniform grain-sized sands are often used in Special Applications such as foundry sand or filter sand.

The sand and gravel industry is a relatively capital intensive industry requiring relatively large land areas for their extractive activities. As mineral aggregates in general are bulky and relatively low value, long hauls have been considered prohibitive. The desire to locate close to urban centres often leads both to competition for land and conflicts with uses spreading out from the urban area.

The preceding section is only a simplified explanation of a complicated industry.

2.3 Sand and Gravel Production

The production of sand and gravel in Niagara from 1972 to 1979 has dropped significantly which is in direct contrast to production registered for Ontario as a whole. As shown in Table 2.1 and illustrated in Figure 2.1 the total production of sand and gravel in Ontario from 1972 to 1979 seems to have fluctuated but there has been a considerable increase in the latter part of the 1970s. In the Niagara Region however, production has generally declined.

In 1972 approximately 6.5 tons per capita of sand and gravel from all sources were produced in Niagara as compared to 9.8 tons per capita in the Province. By 1979, the figure for Niagara dropped to 2.8 tons while Ontario's production per capita rose to 12.3 tons.

Within the Niagara Region licensed sand and gravel production is unevenly distributed. Furthermore, each location may contain different types of sand and gravel and thus influence the range of products produced.

Nine sand and gravel pits are currently licensed under The Pits and Quarries Control Act, 1971. One sand dredger is licensed under The Beach Protection Act. As illustrated in Figure 2.2, sand pits are concentrated in three main areas: Fonthill, St. Davids, and along the Lake Erie shoreline. Three licensed sand dredging areas also exist at the following locations: adjacent to Mohawk Point in Lake Erie, in the Niagara River adjacent to Fort George and in Lake Ontario less than one mile from the mouth of the Niagara River. Figure 2.2 also shows the location of quarries which are discussed in Chapter 4. A few wayside pits were licensed during the 1970s to provide fill but no permits were issued in 1979 or 1980.

Table 2.2 and Figure 2.3 illustrate the 1979 distribution of sand and gravel production. The following discussion describes the type and quality of the deposits in the present licensed sources, the range and costs of products made and the production problems encountered from each of the five major sources listed below:

- The Fonthill Kame
- The St. Davids area
- The Lake Erie shoreline
- Sand dredging in Lake Ontario, the Niagara River and in Lake Erie
- Wayside pits.

Table 2.1

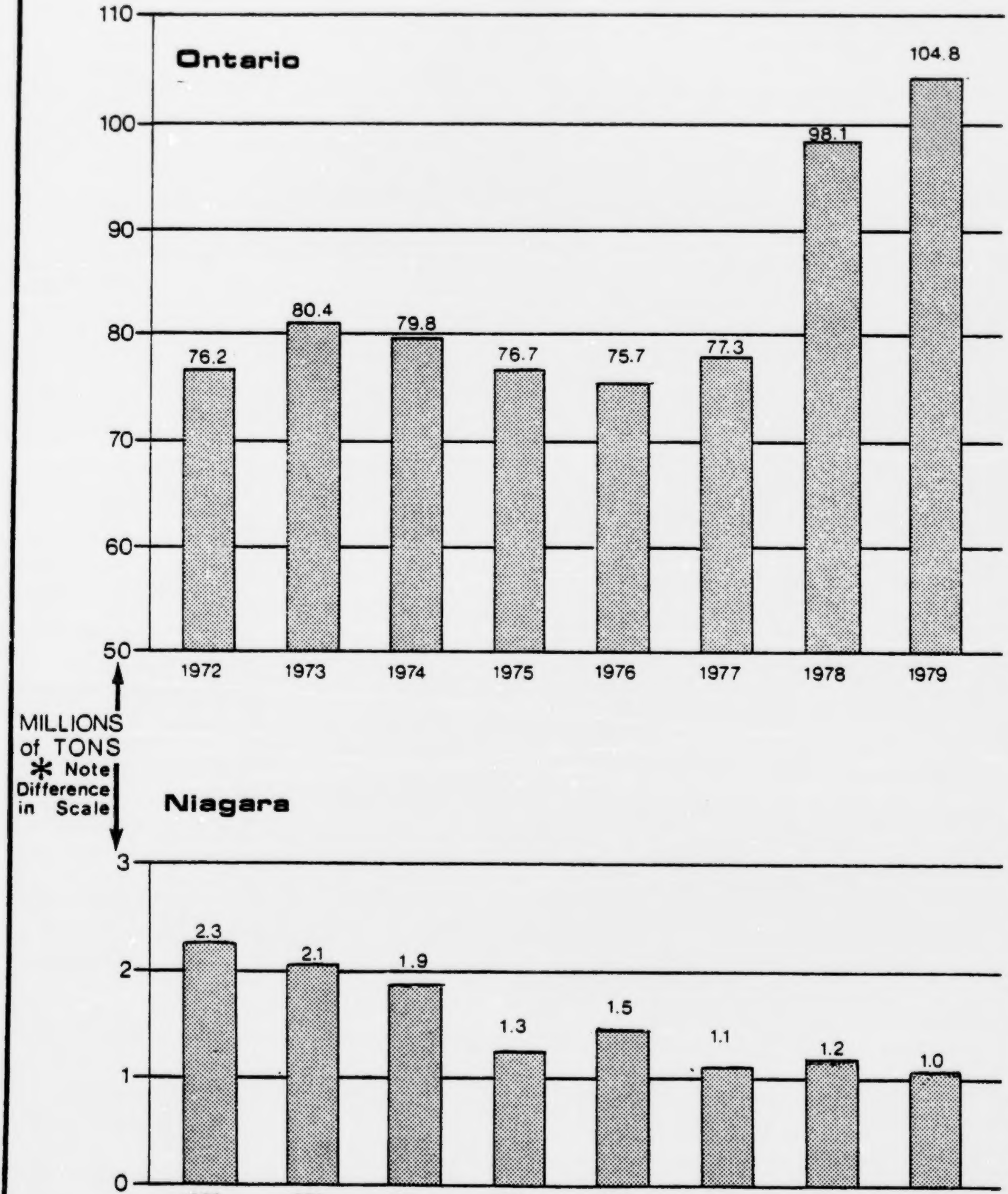
SAND AND GRAVEL PRODUCTION 1972-1979
(000's of tons)

	Niagara Region			Ontario
	Production* from licensed pits under The Pits and Quarries Control Act,1971	Production** from sand dreding on Lake Erie, Lake Ontario & the Niagara River	Total Production	Total production** (This includes land-based pits as well as dredging operations
1972	2090.4	162.0	2252.4	76,219.9
1973	1710.4	350.8	2061.2	80,398.7
1974	1691.8	195.0	1886.8	79,817.0
1975	1093.6	167.6	1261.2	76,675.9
1976	1309.4	143.3	1452.7	75,682.3
1977	1016.3	78.8	1095.1	77,337.5
1978	1058.1	99.5	1157.6	98,137.6
1979	933.5	109.5	1043.0	104,779.4
Average Annual Production from 1972-1979	1362.9	163.3	1526.3	80,609.8

Sources: * Regional Municipality of Niagara Survey of Aggregate Producers, 1980.
** Ministry of Natural Resources, 1981.

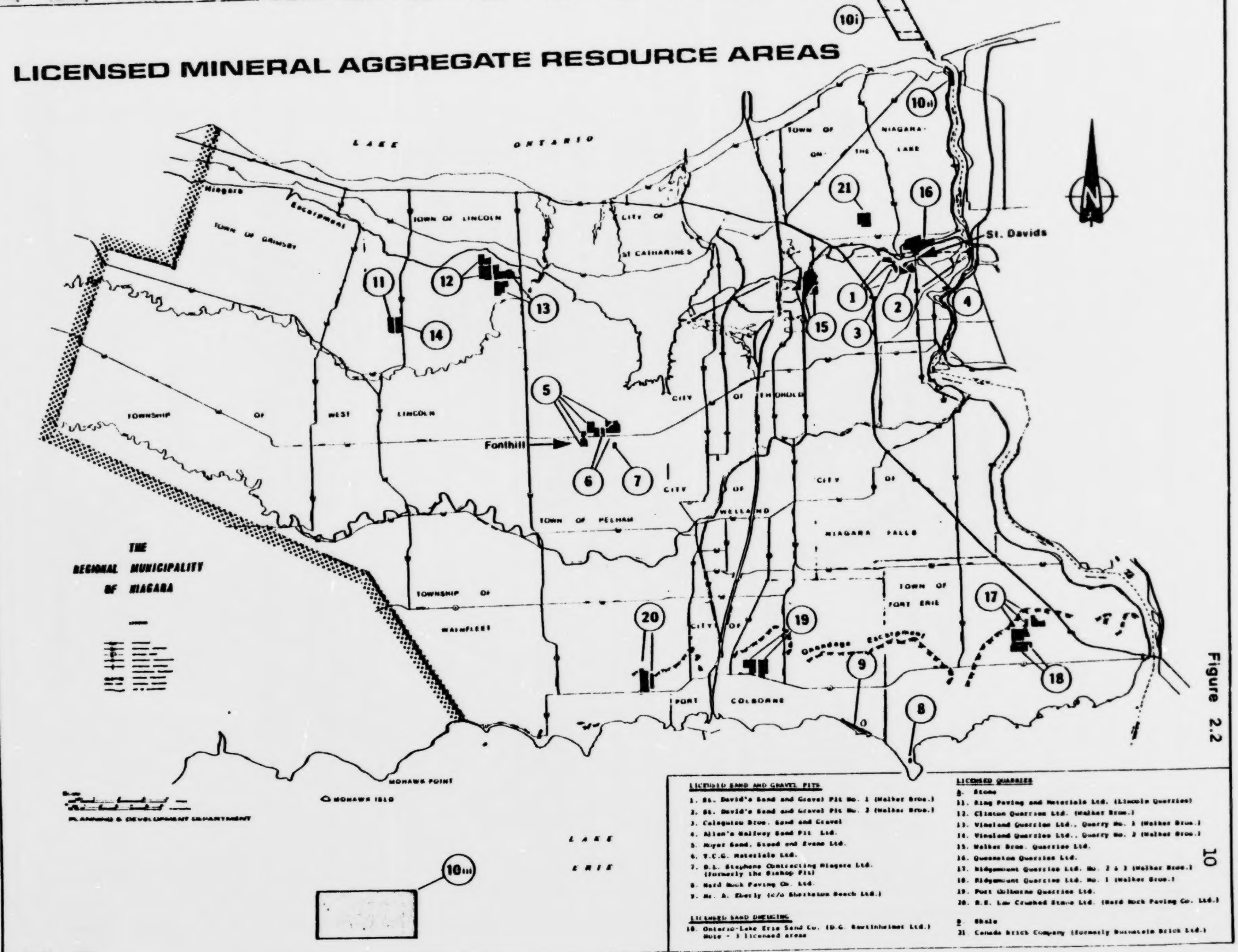
Figure 2.1

Annual Production of Sand and Gravel



LICENSED MINERAL AGGREGATE RESOURCE AREAS

Figure 2.2


10i
10ii
10iii
LAKE ONTARIO
LAKE ERIE
TOWN OF NIAGARA-ON-THE-LAKE
CITY OF ST. CATHARINES
TOWN OF LINCOLN
TOWN OF GRIMSBY
Niagara Escarpment
TOWNSHIP OF WEST LINCOLN
CITY OF THOROLD
CITY OF WELLAND
CITY OF NIAGARA FALLS
TOWN OF PELHAM
TOWNSHIP OF WAINFLEET
TOWN OF FORT ERIE
CITY OF PORT COLBORNE
Onondaga Escarpment
St. Davids
Fonthill
MOHAWK POINT
MOHAWK ISLD
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THE REGIONAL MUNICIPALITY OF NIAGARA
PLANNING & DEVELOPMENT DEPARTMENT
April 1981

LICENSED SAND AND GRAVEL PITS

1. St. David's Sand and Gravel Pit No. 1 (Walker Bros.)
2. St. David's Sand and Gravel Pit No. 2 (Walker Bros.)
3. Calaguiro Bros. Sand and Gravel
4. Allen's Railway Sand Pit Ltd.
5. Moyer Sand, Stone and Evans Ltd.
6. T.C.G. Materials Ltd.
7. D.L. Stephens Contracting Niagara Ltd. (formerly the Bishop Pit)
8. Hard Rock Paving Co. Ltd.
9. Mr. A. Eberly (c/o Sherkston Beach Ltd.)

LICENSED SAND DREDGING

10. Ontario-Lake Erie Sand Co. (D.G. Bostinhelmer Ltd.) Note - 3 licensed areas

LICENSED QUARRIES

a. Stone

11. King Paving and Materials Ltd. (Lincoln Quarries)
12. Clinton Quarries Ltd. (Walker Bros.)
13. Vineland Quarries Ltd., Quarry No. 1 (Walker Bros.)
14. Vineland Quarries Ltd., Quarry No. 2 (Walker Bros.)
15. Walker Bros. Quarries Ltd.
16. Queenston Quarries Ltd.
17. Ridgemount Quarries Ltd. No. 2 & 3 (Walker Bros.)
18. Ridgemount Quarries Ltd. No. 1 (Walker Bros.)
19. Port Colborne Quarries Ltd.
20. R.E. Law Crushed Stone Ltd. (Hard Rock Paving Co. Ltd.)

b. Shale

21. Canada Brick Company (formerly [illegible] Brick Ltd.)

Table 2.2

Distribution of Sand and Gravel Production
Including Dredging in Niagara by Area Municipality - 1979

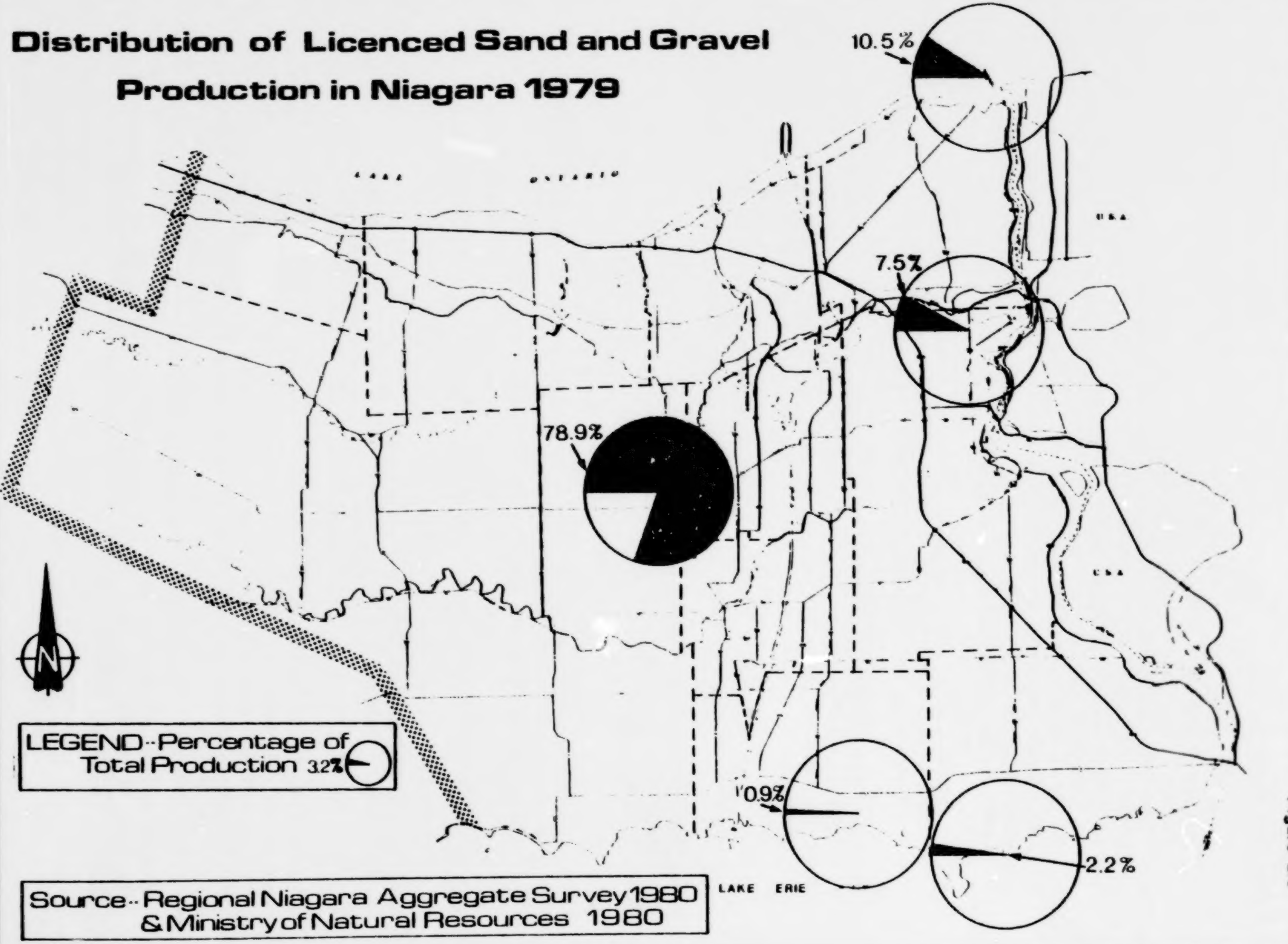
	Number of Operations	Total Production (in 000's of tons)	% of Total Production
Land Based Pits			
I Municipality			
Pelham	3	*823.6	78.9%
Niagara Falls	4	* 78.2	7.5%
Fort Erie	1	* 22.5	2.2%
Port Colborne	1	* 9.2	0.9%
II Dredged Sands from Lake Ontario and the Niagara River	1	**109.5	10.5%
III Total	10	1043.0	100.0%

Source: * Regional Municipality of Niagara Survey of Aggregate Producers, 1980.

** Ministry of Natural Resources, 1981.

Figure 2.3

Distribution of Licenced Sand and Gravel Production in Niagara 1979


10.5%
LAKE ONTARIO
U.S.A.
7.5%
78.9%
U.S.A.
N
0.9%
2.2%
LAKE ERIE

LEGEND -- Percentage of Total Production 3.2%

Source -- Regional Niagara Aggregate Survey 1980 & Ministry of Natural Resources 1980

2.3.1 The Fonthill Kame

In 1979, three pits in Fonthill occupying 462.5 acres (about 187 ha) accounted for about 79% of the Region's sand and gravel production. The average annual production taken from these sources during the last five years for example has been estimated at about 1.2 million tons although the production has dropped to just over 800,000 tons in 1979.

The Kame feature which was created during the retreat of the last glacial age, is an ice-contact glaciolacustrine delta complex which is located beyond the head of the Twelve Mile Creek re-entrant valley in the Niagara Escarpment.

> "Kames are defined as mounds of poorly sorted sand and gravel deposited by meltwater in depressions or fissures on the ice surface or at its margin".*

Since the thicker coarser materials of the Kame are located along the northerly ice-contact portion, extractive activity has tended to focus in these locations. One small licensed operation is located south of Highway No. 20 but the material, according to the Ministry of Natural Resources, is composed of more stratified sands and with some coarser deposits present at greater depths.

The three operations presently produce a wide range of products that include:

Product	Percentage of Total Production*
a) granular A, pit run, 3/4" gravel (granular base and sub-base materials)	31%
b) sand cushion (type of sand fill)	10%
c) sand fill (backfill material)	
d) concrete sand (concrete structures and pavement)	59%
e) asphalt sand (hot-laid asphalt)	
f) winter sand (ice control aggregate)	
g) mortar sand	

* Note: Average for the years 1977 - 1979.

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* Ontario Geological Survey, Aggregate Resource Inventory of the Town of Pelham, Regional Municipality of Niagara, Southern Ontario (Toronto, 1980) p. 27.

Concrete sand, asphalt sand, winter sand and mortar sand are the premier products and command the highest prices per ton compared to other products. The average price of the premier products at the pit falls in the range of $4.00 to $6.00 per ton whereas poorer quality products such as pit run (Granular B), sand fill and fill would cost between $1.00 and $3.00 per ton. These average product prices do not include transportation costs.

There are several problems related to the overall quality of the deposits in Fonthill. The deposits on the Kame generally have a low and variable stone content, the percentage of fine sand material is high (about 20% to 30%), the presence of undesirable reddish clays and silts, and frequent pockets of highly cemented materials, all combine to make extraction and final processing of acceptable aggregate more difficult. Such problems lead to the need for additional processing compared to some deposits found in other parts of Ontario.

In addition to problems of aggregate quality, a more critical concern to local producers at this moment, seems to be the shortage of supply within licensed areas. As a result all three licensed operations are actively seeking to acquire and license additional lands on the Fonthill Kame. More information on the estimated licensed reserves is provided in Section 2.5.

2.3.2 The St. Davids Area

The St. Davids area on top of the Niagara Escarpment has witnessed a great deal of aggregate extraction in the past. This deposit is a well-stratified, well-sorted, ice-contact glaciolacustrine delta at the head of the St. Davids re-entrant valley.

There are four licensed sand pits operating in this area. In 1979 production was about 80,000 tons representing only about 8% of Niagara's sand and gravel production. A long history of extraction saw the removal of coarse deposits which could be made into many products including granular base and sub-base materials, asphalt, mortar and backfill sands. Today, however, fine reddish sands with very little gravel predominate in this location and the range of products available is significantly reduced. The main product sold is fill material which is of a grade that can be used in road and building construction.

Since the deposits are easily extracted and require little processing the product is relatively inexpensive, ranging from $1.00 to $1.50 per ton at the gate. The local producers have indicated that a limited amount of Granular C material may be present in their pits but until there is both a demand and extensive geological testing conducted, they would have no way of estimating the remaining quantities of this type of material.

2.3.3 The Lake Erie Shoreline

The limited sand deposits near the Lake Erie shoreline are mainly in the form of dunes. The dunes are uniformly fine to medium-grained sands relatively rich in quartz minerals.

The two licensed operations excavated about 32,000 tons of sand in 1979 representing the smallest portion of Niagara's sand and gravel production (3%). These pits are situated along the shoreline zone of Port Colborne and Fort Erie where the dune deposits are higher than those located in the western shoreline zone of Wainfleet. The smaller licensed operation is quickly depleting its resource and expects to close in 1981, leaving one sand pit in operation.

Dune sands can be used for a limited range of special products which include:

a) blending sand - for asphalt construction,

b) backfill sand,

c) metal casting sand, and

d) filter sand.

Due to the ease of extraction and because processing is not required, the cost for these products is relatively low and ranges from $1.50 to $2.00 per ton at the gate. Traditionally the largest portion of this material has been blended with clear quarry screenings for binder courses in asphalt production.

Other important users of this fine quartz sand product are local foundries for their metal casting processes. This material does not however, contain a high percentage of silica which is required for other specialized foundry purposes such as used by General Motors.

2.3.4 Sand Dredging in Lake Ontario, the Niagara River and in Lake Erie

In 1973, a peak year, sand dredging contributed about 17% of the overall production of sand and gravel in Niagara. The share in an average year, as 1979 was, is about 11%.

Dredging involves the excavation, transportation and disposal of bed materials. In the Great Lakes system, this activity produces about 12 million tons of material annually. Only about 10% of this amount however, is sand and gravel which is mostly for the construction industry. The majority of

Great Lakes dredging is primarily for navigable waterways and harbour facilities.

Focusing on Niagara, dredging activity has concentrated in three locations for which licenses have been issued by the Ministry of Natural Resources under The Beach Protection Act. These offshore licensed reserves are the 5120 acre block adjacent to Mohawk Point in Lake Erie, a 1,510 acre section of the Niagara Bar in Lake Ontario adjacent to Fort Mississauga, and finally a 48 acre block in the Niagara River adjacent to Fort George. These licensed areas are shown on Figure 2.2.

In the early 1970s several sand dredgers were actively mining in the vicinity of Niagara but due to numerous licensing and production problems only one company now has a license to mine in the three areas previously noted. By way of comparison, five American commercial dredgers operate mainly in Lake Erie on the U.S. south shore. In 1974, they removed almost 685,000 tons of construction-grade aggregate. In the Niagara and Point Pelee areas, only about 260,000 tons of material were produced in the same year.

The production of dredged sand and gravel in Niagara has fluctuated significantly in the 1970s. The data presented in Table 2.3 indicate a relative peak in the early 1970s with a general decline since. This is explained by the Ministry of Natural Resources' staff to be due to the decline in numbers of dredging vessels licensed to operate.

Although very little information seems to be known about the quality of dredged bed materials especially in deep waters, discussions held with the Ministry of Natural Resources, Canada Center for Inland Waters (C.C.I.W.), U.S. Corps of Army Engineers, and a local dredging operator indicate that the deposits found in Lake Ontario are of a higher quality for construction use than those deposits found in Lake Erie sources. Near shore sediment surveys recently conducted by the C.C.I.W. and several New York state colleges indicate that the only gravel and pebbly sands found in Western Lake Ontario in the vicinity of the Niagara Region are located mainly in the Niagara bar adjacent to Niagara-on-the-Lake. These deposits are mainly fine to medium coarse sands with some gravel and pebbly material present. A smaller amount of silt and clay is also present which is considered a deleterious material for construction use. Dredged material taken from Lake Erie on the other hand contains a high percentage of clay, silt and fine sand. Thus,that dredged material is generally suitable as a fill material only.

Table 2.3

Dredging Production
in Niagara

YEAR	PRODUCTION FROM SAND DREDGING IN LAKES ONTARIO, ERIE AND THE NIAGARA RIVER
	(000's of tons)
1972	162.0
1973	350.8
1974	195.0
1975	167.6
1976	143.3
1977	78.8
1978	99.5
1979	109.5

SOURCE: Ministry of Natural Resources, 1981.

The deposits dredged under license at the mouth of the Niagara River yield two main types of natural sand products: concrete sand and brick or plaster-grade sand. Although the deposits are not as coarse as those from Fonthill, a wide range of Fine Aggregate and special application-type materials are being produced from dredged deposits including:

a) concrete products, ie. block, brick, catch basins, and reinforced facade,

b) binder materials, ie. cement

c) foundry sand, ie. firebricks,

d) winter sand, and

e) agricultural-related materials, ie. sand high in silica (60% to 85%) for ph control, drainage, filter beds.

The average cost per ton of concrete or plaster-grade natural sand ranges from $4.50 to $5.00 in Niagara and would include ship transportation costs to two land-based facilities located in Queenston and Port Dalhousie. This price does not include truck transportation and distribution costs from the dock facilities.

In 1979 about 49% or 54,000 tons of the total dredged sand was sold in Niagara whereas the remaining production was sold outside the Region primarily in the Hamilton market.

Numerous problems have plagued the dredging industry in the latter half of the 1970s resulting in significant production declines. These problems are summarized below:

a) Licenses are renewed on a yearly basis rather than for three year intervals as is the case in the United States. Land-based sand and gravel operations on the other hand are licensed until the resource is fully extracted. An annual license review places a degree of future uncertainty and discourages any renewal of capital investments in equipment and shore facilities.

b) The extent and quality of deposits within the licensed area is uncertain due to the lack of research.

c) The demand for construction materials has dropped drastically due to the decline in new housing starts or major road construction projects.

d) Skilled shipping labour from the Seafarers International Union commands high wages.

e) Dredging zones are in Crown territory therefore royalty rates must be paid to the Province. In 1981 these rates were set at 25 cents per cubic meter. The dredging operator feels that he is at a disadvantage because this rate is more than twice as high as the "per ton" security deposit paid out by land-based operations.

f) Dredged deposits in Niagara contain deleterious materials such as coal, wood, shells, potassium, etc. which must be removed to meet government specifications. The technology to remove such materials is available but it is costly.

g) Future expansion of the dredging operation in Niagara may require additional land-based facilities for storage, processing, and possibly another vessel all of which are expensive.

Despite the problems encountered in the dredging industry the only producer in Niagara anticipates more growth in the future and feels his contribution to competition in the market place forces the aggregate industry to keep the costs of sand and gravel products to the consumer down. Certainly, aggregates from dredging as an alternative source to the diminishing supplies of land-based sand and gravel pits deserves further consideration. The quality of the deposits and estimates on reserve tonnages are two areas that deserve closer consideration.

2.3.5 Wayside Pits

A wayside pit, which is licensed by the Ministry of Natural Resources under The Pits and Quarries Control Act, 1971 is described as a temporary pit "opened and used by a public road authority solely for the purpose of a particular project or contract of road construction and not located on the road right of way".

Information received from the Ministry of Natural Resources for the period between 1974 and 1979 indicates that wayside pit activity has not been widespread in the Niagara Region. Moreover, wayside pits have been used to provide only earth fill.

The Ministry's records indicate that most of the activity has concentrated near Douglastown in the Town of Fort Erie in the vicinity of the Queen Elizabeth Highway. Two other small wayside pit permits were issued. One is located at the Marshall Road - Q.E.W. junction in Niagara Falls and the other is near the Snider Road - Highway #140 intersection in the City of Port Colborne.

In 1977 about eight wayside pits were being used. These earth borrow pits which ranged from 3 to 9 feet in depth, were licensed to yield approximately 1.4 million tons of construction earth fill material (clay, silt and minor sand) and were primarily used in various Ministry of Transportation and Communications highway projects. No wayside pit permits were issued by the Ministry of Natural Resources in 1979 or 1980 however.

2.4 Exports and Imports

Most of Niagara's sand and gravel requirements are being met from local supplies but small amounts of material are exported and imported.

About 89,000 tons, or 8.5% of Niagara's total sand and gravel production was exported to Haldimand-Norfolk, Hamilton-Wentworth and the U.S.A. As shown in Table 2.4, about 56,000 tons of the exportsare dredged material. Also, ready-mix, asphalt and concrete product companies sell some of their finished products outside Niagara. The quantities of these products leaving Niagara however could not be determined.

Table 2.4

Imports and Exports of Natural Sand and Gravel in 1979

Source	Tonnage
Exports from	
Land-based pits (Fonthill)	33,000
Dredging (Niagara bar)	56,000
Total	89,000*
Imports from	
United States (Michigan)	139,800
Land based pits in Ontario (Brantford-Cambridge)	3,400
Total	143,200**

Source: * Regional Municipality of Niagara Survey of Aggregate Producers, 1980.
** Regional Municipality of Niagara Survey of Users, 1980 and Marine Transport Unit, Statistics Canada, 1980.

In attempts to discover if significant quantities of sand and gravel are exported to the United States, the Bureau of Mineral Resources, a branch of the New York State Department of Environmental Conservation, was contacted. Discussions revealed that while Erie County (including the Buffalo area) had abundant sand and gravel resources for all types of products, Niagara County to the north (which includes Niagara Falls and Lewiston, New York) had a shorter supply and a more limited range of products.

Bureau staff indicated that although a small amount of sand and gravel was imported to the Lewiston, New York area from the Town of Pelham in 1980, licensed reserves in both Erie and Niagara Counties are sufficient for at least the next 10 years. This is primarily due to the slow growth in construction which is expected to continue for at least the next five years.

Municipal governments use sand and gravel materials especially for road construction and maintenance, water and sewer projects, etc. In an attempt to discover their sources of supply, a municipal information questionnaire was sent to the two adjacent Regional Municipalities of Hamilton-Wentworth, Haldimand-Norfolk and the five adjacent area municipalities including Hamilton, Stoney Creek, Glanbrook, Dunnville, and Haldimand. The information received to date reveals that no sand and gravel is exported from Niagara to meet the needs of adjacent municipalities. Their needs are satisfied by closer local sources of supply.

Based on the information gathered for this study it appears that about 91% of the sand and gravel produced in Niagara is used here while about 9% is exported.

As far as imports are concerned, about 143,000 tons of "specialized" sand and gravel were imported in 1979 (see Table 2.4).

The bulk of this material (98%) is a high quality, uniformly-grained silica sand used for foundry purposes at General Motors in St. Catharines. General Motors searched in conjunction with the Federal and Provincial governments to locate adequate Canadian sources but discovered the nearest possible source to be in Manitoba. The fine-grained Lake Erie dune sands are not uniformly-grained or rich enough in silica to meet General Motor's needs. As a result, fine silica sand is imported annually from the State of Michigan for General Motor's use.

The remaining portion of Niagara's known imports is accounted for by the requirements for a "specialized" gravel called "pea gravel". This material which is sometimes used for roofing purposes, is not available in Niagara. Therefore, about 3,400 tons were brought in from the Brantford-Cambridge area by local companies who have other pits in those locations.

The twelve area municipalities in Niagara have indicated in their completed municipal questionnaires that all of their sand and gravel requirements from pits since 1975 have been met by supplies from within Niagara. It is noted however that over this time period the Township of West Lincoln has been importing a small amount (about 275 tons annually) of manufactured sand from a quarry in the Dunnville area for winter sand purposes.

From a survey of 24 local companies who use sand and gravel to make various products, 17 have responded and indicate that mainly local supplies have been purchased for their purposes. It was noted however that occasionally some companies have imported small quantities of sand and gravel from outside Niagara in special situations where the cost may have been attractive or when specialized products, not produced in Niagara, were required. Generally speaking though these quantities are not of significant amounts.

The Regional Niagara Public Works Department has indicated that all of their purchases of sand and gravel have been from sources located within Niagara.

2.5 Estimated Licensed Reserves

Based on the information received from both the Ministry of Natural Resources and the aggregate producers, there is an estimated 12 to 14 million tons of sand and gravel remaining in all licensed "land-based" pits in Niagara (see Table 2.5) In addition, there are unknown quantities of sand and gravel within areas licensed for dredging.

Although at first glance, a significantly large supply of material seems to be available from licensed sources, the full range of products cannot be produced from all the licensed reserves. For example, the St. Davids' pits which contain more than 50% of the estimated total licensed reserve of all "land-based" sources is suitable primarily for backfill and perhaps some low quality granular material because the remaining reserves are fine sands. The amount of reserve available in the St. David's area could be signficantly reduced if two subdivision proposals within the existing licensed area were approved. Fonthill on the other hand which contains less than 50% of the licensed reserve contains a much wider range of fine to coarse materials suitable for many more products including gravel and concrete sand. The deposits along the shoreline of Lake Erie are the finest grained in Niagara and have been used for a limited range of products. Given the limited reserves in this area, other sources of supply may be required to satisfy the need.

Table 2.5

Estimated Licensed Reserves of
Sand and Gravel
(in 000's of tons)

Area	Tonnage
Pelham	4,000.0 - 6,000.0
Niagara Falls	± 8,000.0
Fort Erie Port Colborne	130.0
Dredging from Lake Ontario and the Niagara River	Tonnage unknown but a +25 year supply is estimated by the producer
Total	12,130.0 - 14,130.0 (plus undetermined sand dredging reserves)

Source: Ministry of Natural Resources, 1980 and Regional Municipality of Niagara Survey of Aggregate Producers, 1980.

For dredging, reserve capacity from licensed sources in the Niagara deposit is difficult to quantify. Some research has been conducted by the Great Lakes Laboratory of the State University College in Buffalo and the Canada Center for Inland Waters in Burlington, Ontario. Much more work needs to be done however concerning both the quantity and quality of these deposits. One study conducted by the International Association of Great Lakes Research in 1970 estimated that there may have been between 120 million and 180 million tons of sand and gravel in what they term the "Niagara Deposit". It is noted that this data pertains to the entire Niagara deposit which extends out from the Niagara River mouth far beyond the boundaries of the currently licensed dredging zone and into American as well as Canadian waters.

Chapter 3

POSSIBLE SAND AND GRAVEL RESOURCE AREAS IN NIAGARA

3.1 Introduction

This chapter looks beyond licensed supplies of sand and gravel in an effort to identify other areas in Niagara containing similar resources. These possible resource areas have been mapped and described on individual inventory sheets which appear in Appendix 4. Although this exercise is preliminary in nature, some potential reserve estimates have been tallied for the Region. The potential uses of the deposits are unknown in most cases however. The information provided here serves to "flag" possible resource areas and to generally describe some of their characteristics. Further field checking, drilling and laboratory analyses are required to more clearly identify the quality, quantity and potential uses of these possible sand and gravel resources.

The Ministry of Natural Resources is the major source for much of the basic information set out in this chapter. Some of the data was partly derived from unpublished Ministry field notes but the maps and their accompanying descriptions were prepared by Regional staff. Furthermore, the boundaries of the possible resource areas may not be precise and are subject to more detailed study.

Although most of the descriptionspresented here are of a preliminary nature, two more detailed evaluations of sand and gravel deposits in Pelham and Welland have recently been completed by the Ministry of Natural Resources and are included.

3.2 Overview of the Possible Sand and Gravel Resource Areas

The possible resource areas, which are shown in a general way on Figure 3.1 may be grouped under seven main headings:

- Lake Iroquois Beach and Bar Deposits
- The Deposits of Niagara Falls
- The Fonthill Kame
- Isolated Inland Beach and Bar Deposits
- Wainfleet and Lake Erie Dunes
- Off-Shore Deposits
- Other Deposits

Key Map of Possible Sand & Gravel Resource Areas

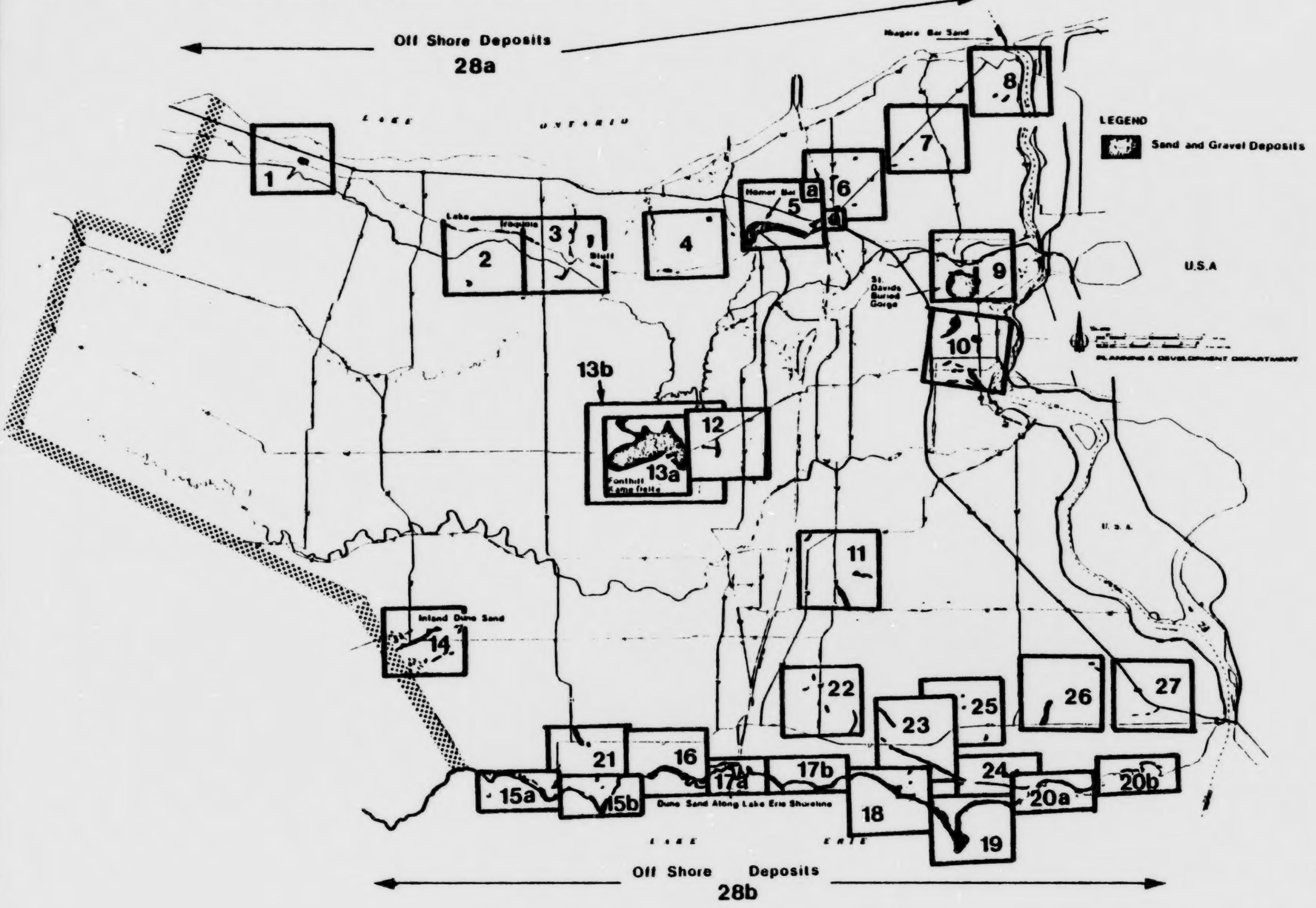

Off Shore Deposits
28a
LAKE ONTARIO
Niagara Bar Sand
LEGEND
Sand and Gravel Deposits
U.S.A
PLANNING & DEVELOPMENT DEPARTMENT
1
2
Lake Iroquois Bluff
3
4
Homer Bar
5
a
6
7
8
9
St. Davids Buried Gorge
10
11
12
13a
13b
Fonthill Kame Delta
Inland Dune Sand
14
15a
15b
16
17a
17b
18
19
20a
20b
21
22
23
24
25
26
27
U.S.A.
Dune Sand Along Lake Erie Shoreline
LAKE ERIE
Off Shore Deposits
28b

Figure 3.1

A brief description of each of these groupings will follow to give an overview of the types and characteristics of the scattered deposits which are present in Niagara. The various maps listed below locate the deposits and Figure 3.1 shows the location of the maps in the Region. The individual maps are found in Appendix 4.

3.2.1 Lake Iroquois Beach and Bar Deposits (Map Nos. 2 to 8)

A series of beach and bar deposits extend along the former Lake Iroquois shoreline from Beamsville to Niagara-on-the-Lake. The largest and deepest of these deposits is the Homer Bar which traverses the City of St. Catharines. Most of this deposit is covered by urban development rendering it unavailable for extraction. Some material may be available in the deposits found in Lincoln and Niagara-on-the-Lake. Most of these deposits are quite small and shallow but their use as wayside pits may be possible.

Constraints to development of these deposits generally may include residential development, roads, orchards and vineyards.

3.2.2 The Deposits of Niagara Falls (Map Nos. 9 and 10)

Eight sand and gravel deposits are located in the St. Davids, Stamford and Lundy's Lane areas of Niagara Falls. These deposits are described as Lake Warren and pre-Iroquois deposits of sand and gravel.

A significant amount of extraction has occurred in the past particularly for the coarser materials in the St. Davids area. Today, fine reddish sands appear to be left and may be used for fill purposes in road and building construction.

The quantity, quality and potential uses for the deposits located in the Stamford and Lundy's Lane areas is unknown. The major constraint to their use is extensive urban development.

3.2.3 The Fonthill Kame (Map Nos. 13a and 13b)

The Fonthill Kame, formed by glacial and lake action, is the largest and coarsest, land-based deposit of sand and gravel in Niagara. Total potential reserves outside licensed sources are estimated at 95 million tons.

Potential reserve estimates have not been determined for the finer sands and silt sediments located at the extremities and beyond the Kame feature.

Constraints to development of this resource include rural residential and urban development, agricultural activities and environmental considerations.

3.2.4 Isolated Inland Beach and Bar Deposits

(Map Nos. 11 and 21 to 27)

Several proglacial beach and numerous glaciolacustrine beach/off-shore bar deposits of sand and gravel are scattered throughout Wainfleet, Port Colborne, Welland and Fort Erie. Many of these deposits are shallow, linear in nature, and are situated on the Onondaga Escarpment.

Although the deposits are shallow, there is some potential for pit activity. A number appear to have been used in the past.

Two of the more important locations may be the deposits located southeast of Welland and north of Ridgeway. The Ministry of Natural Resources has assessed the Welland area in some detail and indicates that some wayside pit activity may be possible. The probability of obtaining crushable aggregate is felt to be low however. The Ministry has also expressed some interest in the deposit north of Ridgeway and may study it in more detail at some point.

Constraints to development of many of these deposits may include such uses as rural residential and urban development, roads, cemeteries and golf courses.

3.2.5 Wainfleet and Lake Erie Dunes (Map Nos. 14 to 20)

Two sources of wind-blown dune sand exist in the Niagara Region. The first is a field of parabolic, inland sand dunes that lie west of the village of Wainfleet, and the second is a narrow strip of longitudinal dunes that line most of the Lake Erie shoreline behind its beach. Generally speaking, the shore and inland dunes vary in height and their sand is uniformly fine to medium-grained being rich in quartz minerals. The inland dunes however, tend to be finer and more loamy than the shoreline deposits.

In the past some extraction has occurred in both the shore and inland dune deposits. Their uses, which are limited but specialized, included blending for asphalt-making and filtration purposes.

Although there may be some potential for further extraction of these deposits, established residential development and environmental considerations may limit the activity.

3.2.6 Off-Shore Deposits (Map Nos. 28a and 28b)

Off-shore deposits (some being dredged) are present in Lake Ontario, Lake Erie and the Niagara River. Although little seems to be known about the quantity and quality of these bed materials it appears that the deposits in Lake Ontario are of a higher quality than those in Lake Erie. The Niagara River mouth deposit adjacent to Fort George in Niagara-on-the-Lake, for example, contains fine to medium-course sands with some gravel which can be made into concrete and brick or plaster-grade products. Lake Erie deposits on the other hand contain clay, silt and fine sand which are generally suitable for fill purposes.

Total possible reserves in the deposit at the mouth of the Niagara River were estimated to be between 120 million and 180 million tons in 1970. This deposit, which includes two existing licensed areas, extends out into Lake Ontario in both Canadian and American waters as a broad fan-shaped delta area. The coarser sands and gravels are found near the river mouth with finer deposits occurring lakeward. Some believe that this deposit is replenishing itself and may be a continuous source for aggregate.Possible constraints may include the presence of deleterious material and environmental considerations.

Total possible reserve estimates in Lake Erie and other Lake Ontario deposits are unknown at this time.

3.2.7 Other Deposits (Map Nos. 1, 2 and 12)

Four small sand and gravel deposits are situated in Grimsby, Lincoln and Pelham-Thorold.

The shallow deposits in Lincoln and Pelham-Thorold are Lake Warren and younger pre-Iroquois beach and bar deposits. Their potential uses are unknown at this time. Constraints to development may include houses, roads, commercial establishments and orchards.

The coarse alluvial fan deposit situated in the downtown portion of Grimsby is unavailable for extraction due to urban development.

3.3 Sand and Gravel Reserves

Due to the unavailability of quantitative and qualitative data for all deposits (both land-based and off-shore), total reserve estimates for Niagara could not be calculated. Furthermore, a breakdown of the different types of sand and gravel (i.e. fine sand, coarse gravel, etc.) available cannot be determined.

Based on the information available for land-based areas outside licensed sources, total known possible reserves are estimated at about 100 million tons. Of this amount, 95% is found on the Fonthill Kame while the remaining supply is from the many small, relatively shallow deposits scattered throughout the Region. These estimates do not include the St. Davids area in Niagara Falls, the Homer Bar in St. Catharines, the edges of the Kame in Pelham, the inland dunes in Wainfleet and the shore dunes along Lake Erie. No estimates could be determined for these deposits either because they were covered by urban development or quantitative data were not available.

Some qualitative information is available for the off-shore deposits in Lakes Ontario and Erie and the Niagara River. However little seems to be known about the quantities of materials which may be present. The total reserve estimates set out above does not include materials from these off-shore sources.

Chapter 4

ALTERNATIVES TO THE PRODUCTION OF SAND AND GRAVEL FROM LAND BASED PITS

4.1 Introduction

In the management of sand and gravel resources, the consideration of alternatives to substitute for land-based sources of sand and gravel is becoming of more importance. In the future these considerations will be of even greater significance as available sources of naturally occurring sand and gravel are depleted or encounter increasing conflicts with other resources. Four prime factors are involved in the evaluation of alternatives:

1) the suitability - does the material meet the specifications for the products to be produced?

2) the quantity - how much is available now and in the future?

3) the location - how far from the market is the material?

4) the cost - what is the relative cost of the alternative compared to natural sand and gravel?

For the different alternatives, each of these factors will be of different significance but all must be considered.

Five major alternatives to land based pits in the Niagara Region will be considered in this chapter:

1) importing sand and gravel from other areas in Southern Ontario;

2) dredging of sand and gravel from the Niagara River and Lakes Erie and/or Ontario;

3) the replacement of sand and gravel products with products produced in quarries;

4) the substitution of industrial waste products for sand and gravel; and

5) the substitution of other building materials for building materials produced from sand and gravel.

4.2 Importing Sand and Gravel

The discussion of importing sand and gravel from other areas will be focussed on two factors: one, where other supplies are located; and two, what are the cost implications of importing the material by various modes of transportation.

4.2.1 Possible Sources of Supply

As sand and gravel is a bulky, relatively low value material and the transportation costs are a major portion of the final selling price, the most attractive alternatives would be those with the lowest transportation costs. As such, the closest sources are considered the most promising in the short-term.

The closest available licensed supplies are located in the Milton, Brantford-Paris and the Cambridge-Guelph areas (Figure 4.1). In these areas there are a number of producing pits which are located approximately fifty to seventy miles from the center of Niagara. Although these operations are currently producing sand and gravel and are in areas with large reserves, there are no guarantees that any of the operations have the capacity to supply the Niagara Region's needs.

In the longer term, the movement by ship of large volumes of sand and gravel from presently unlicensed areas such as Grey and Bruce, may also be considered as an alternative.
The feasibility and cost of large volume movements of mineral aggregates by a variety of modes is currently being investigated by the Ministries of Natural Resources, and Transportation and Communications. Their report is expected to be released in April of 1981. That report should provide the information required to evaluate the feasibility of the long distance movement of aggregates.

4.2.2 Alternative Modes of Transportation

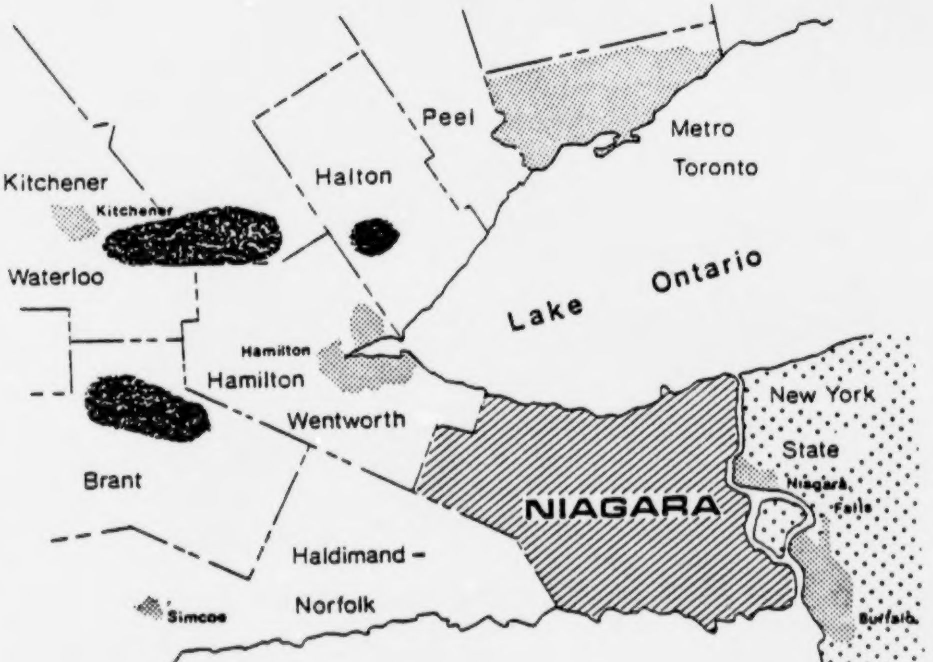
The three potential modes for the movement of aggregate into Niagara are:

- ship,
- rail, and,
- road

Each of these methods of transportation has its own advantages and disadvantages depending upon the length of the haul and the volume of material to be transported. These are summarized in Table 4.1. In very general terms, trucks are more

Figure 4.1

Location of the Closest Sand and Gravel Deposits in Ontario


Peel
Metro Toronto
Kitchener
Halton
Kitchener
Waterloo
Lake Ontario
Hamilton
Hamilton
Wentworth
New York State
Niagara Falls
NIAGARA
Brant
Haldimand – Norfolk
Simcoe
Buffalo
Lake Erie
USA
N

LEGEND·· Alternative Supply Areas ▨

Table 4.1

COMPARISON OF TRANSPORT MODES

	SHIP	RAIL	TRUCK
Operating Costs	- cheapest per ton haul rate for long distance moves of 200 miles or more	- most economical for intermediate distances of 50 - 200 miles	- most economical for short hauls up to about 30 miles but larger trucks may be economical up to 75 miles
Capital Costs	- ships are very expensive ($30m-1976) and need expensive docking facilities (minimum $3m - $4m if new - 1976)	- moderately expensive for new equipment ($4m - 1979) and if new rail lines are needed ($½m/mile) - need re-distribution yard at destination ($?)	- lowest of three as trucks are not as capital intensive (up to $100,000) - if highway costs included then more expensive
Volume	- able to move very large volumes 25,000 - 30,000 tons per ship per trip	- able to move variety of volumes but most economic for larger volumes - unit train of 60 cars capable of moving 6000 tons/train	- individual unit can carry 20 - 40 tons
Flexibility	- source of material and delivery point must be on/near water - least flexible	- source of material and delivery point must have access to railway - moderately flexible	- most flexible in terms of both areas to be served and amount to be moved
Energy Efficiency	- most efficient per ton-mile over longer distances	- moderately fuel efficient over longer distances	- least fuel efficient over longer distances

flexible in terms of areas to be served and require relatively small capital expenditures whereas the other two modes are less costly per ton-mile for long distance hauls but are less flexible and require large capital expenditures.

If sand and gravel were to be imported, in the short term, only the closest licensed supplies can be considered as alternatives. As Brantford, Cambridge and Milton are not on a navigable waterway, only the rail and road modes are considered as alternatives.

If Niagara was to consider importing to meet its longer term needs, all three modes of transportation could be considered. As an example of the representative costs of the three modes for long distance hauls the costs of importing stone from the Prescott area to serve the Toronto market was reviewed by the Mineral Aggregate Working Party in 1976. For the approximately 210 mile haul to Toronto, the following transportation costs were determined:

1) water - \$2.86 to \$4.37 per ton depending on whether existing or new ships were used;

2) rail - \$6.00 per ton assuming new equipment; and

3) road - \$10.75 to \$10.97 per ton depending on whether existing or new trucks are used.

These estimates clearly show the lower transportation costs of both water and rail transportation compared to road transportation for longer distances. These estimates include an allowance for capital expenditures such as docks, ships, and new railway equipment and new trucks. The joint MNR - MTC Bulk Transportation study should provide additional up-dated information needed to evaluate this alternative when it is released in April.

4.2.3 Cost Comparison - Truck vs. Rail

The areas of alternative supply are located approximately fifty to seventy miles from the centre of the Region. The costs presented can only be considered as indications of the relative costs of the two modes.

Rates for hauling aggregate in the Niagara Region are essentially established by the Niagara Region Aggregate Haulers Associates. Normally, these rates are used on most major projects including those done by the Ministry of Transportation and Communications. The basic haul rate is \$0.88 for the first mile and \$0.08 for each additional mile. This rate was developed to be used for the normal movements of aggregate, say less than 20 miles. It has been suggested that for longer hauls a flat rate of \$0.07 per mile may be more appropriate. For present purposes, a range of costs based on the two rates are considered.

Rates and conditions for aggregate hauling by rail are published for existing aggregate hauls. Small volume irregular movements of aggregate by rail can be expensive. Guaranteed large volume movements of 450,000 tons or more have much cheaper rates. Table 4.2 provides examples of existing large volume rail haulage rates into the Toronto area. From a review of Table 4.2, it is noted that whether the material is shipped 48 miles from Limehouse to Scarborough or 97 miles from Uhthoff to Milliken, the same range of rates is quoted. As the movement of aggregate from the alternative supply areas would be within that distance range, a rate of $2.68 per ton will be used for purposes of this study.

A comparison of the rates is shown on Table 4.3. Rail rates would be between 55% to 76% of truck rates. In considering these estimates for rail haulage, the costs of a centralized redistribution yard and possibly new railway equipment must be considered. Also, to get these cheap rates, large volumes in the order of 450,000 tons per year are required. A detailed feasibility study would be required to evaluate the alternatives if it was proposed to import large volumes of sand and gravel.

Table 4.3

Comparison of Road vs. Rail Haulage Costs

Alternative Sources	Distance (miles)	Road Haulage		Rail Haulage	Rail as a %age of Road (low)
		Stnd. Rate	$.07/mile Rate		
Milton	50	$4.80	$3.50	$2.68	76%
Brantford	60	$5.60	$4.20	$2.68	64%
Paris	65	$6.00	$4.55	$2.68	59%
Cambridge	70	$6.40	$4.90	$2.68	55%

Source: Rail Rate - Based upon CFA Tariff 4415 - Items 18800 - Supplement 34

Road - Based upon 1981 rates of the Niagara Aggregate Haulers Associates (Modified)

4.2.4 Impact on Local Selling Price

For purposes of this discussion, sand and gravel products will be arbitrarily divided into two groups:

1) low value products, such as Granular A, pit run. These products are normally sold in Niagara for between $1.85 and $ 2.65 at the pit gate; and

Table 4.2

RAIL RATES FOR SAND, GRAVEL AND STONE MOVEMENTS IN THE TORONTO AREA

Shipper	Origin	Destination	Miles	Rate/Ton	Cost/ Ton-Mile++	Number of Cars Per Movement	Railways
Indusmin Limited	Limehouse	Pinecrest	28	2.11 - 2.16*	$.07.71	50	CNR
Indusmin Limited	Limehouse	Scarborough	48	2.33 - 2.68**	$.05.58	50	CNR
Limestone Quarries Limited	Paris	Milliken	100	2.56 - 2.63**	$.02.63	50	CNR
Limestone Quarries	Uhthoff	Milliken	97	2.33 - 2.68**	$.02.76	50	CNR
Limestone Quarries	Uhthoff	Scarborough	100	2.47 - 2.50+	$.02.50	50	CPR

* Lower rate is applicable on volumes not less than 550,000 tons per annum, higher rate is applicable on volumes of not less than 450,000 tons per annum. (Effective April 1, 1980 to March 31, 1981)

** Lower rate is applicable on volumes of not less than 650,000 tons per annum, higher rate is applicable on rates not less than 450,000 tons per annum. (Effective April 1, 1980 to March 31, 1981)

+ Lower rate is applicable on volumes not less than 350,000 tons per annum, higher rate is applicable on volumes of not less than 250,00 tons per annum.

++ Based on highest rate.

Source: CFA Tariff 4415, Items 18800 Supplement 34 and 18900.

2) high value products, such as concrete, asphalt, mortar and winter sands. These products are normally sold in Niagara for between $4.65 and $5.50 per ton at the pit gate.

The at gate prices for representative products were compared for Brantford and Fonthill. It was found that due to the differences in the quality of material that required different processing, there were also different selling prices. The low value products were generally found to be about $0.40 per ton more expensive and the high value products about $1.00 per ton less expensive in Brantford compared to Fonthill.

Table 4.4 illustrates the theoretical impact of the additional transportation costs and the variation in at the gate prices of importing sand and gravel from Brantford to Niagara. It must be stressed that the transportation costs presented are considered only representative for comparison purposes. If importing were to occur, actual charges would be subject to negotiation and may differ.

As shown in Table 4.4, there would be a significant price increase in Niagara for the low value products whether shipped by rail or by truck. The minimum increase for low value products would be approximately 112% if large volumes were shipped by rail and approximately 249% if shipped by truck. For high value products, the price increase would be approximately 30% if shipped in bulk by rail and 60% if shipped by truck. In addition, there would be the capital costs associated with either transportation mode.

It should be stressed that the selling prices shown are purely theoretical. There are a number of interacting market forces at work which could result in the selling prices being either higher or lower than shown (eg. substitution of quarry material).

Table 4.4

THEORETICAL SELLING PRICES PER TON OF SAND AND GRAVEL IF IMPORTED FROM BRANTFORD

Product Value	At Gate Prices (per ton)		Additional Transportation Costs (per ton)		New Selling Price (per ton)		% Change in Price	
	Fonthill A	Brantford B	Rail C	Truck D	Rail B+C	Truck B+D	Rail $\frac{B+C-A}{A}$	Truck $\frac{B+D-A}{A}$
Low	1.85	2.45	$2.68	$4.20	5.13	6.45	132%	249%
	2.65	2.95	2.68	4.20	5.63	7.15	112	170
High	4.65	3.45	2.68	4.20	6.13	7.65	32	64
	5.50	4.50	2.68	4.20	7.18	8.70	30	58

Sources: Transport costs based on lowest cost of rail and road transport rates in Table 4.3.
At gate prices from published price lists.

4.3 Dredging

There is probably less known about this alternative than any other beingconsidered in this chapter. Much of the evaluation is dependent on information available from the existing dredging operation.

Dredging on the Great Lakes at this time is not a major source of sand and gravel in either Canada or the United States. Dredging though can make a significant local contribution. Dredging today provides about 11% of Niagara's overall sand and gravel production, but has provided as much as 17% in 1973.

As was shown in Chapter Three, there are off-shore deposits of sand and gravel in both Lakes Erie and Ontario and the Niagara River. The deposits in Lake Erie are primarily sand whereas the deposits in Lake Ontario are a mixture of gravel and pebbly sand and gravel. It would appear from the present use of the material that the Lake Erie material may be suitable only for uses such as fill. There are no estimates of the volume of the deposits in Lake Erie.

The present use of the deposit at the mouth of the Niagara River indicates that at least within the present license that the material is suitable for use as concrete, mortar and winter sands. As with land-based deposits, the Niagara River mouth deposits also contains deleterious materials which include shells, wood, glass and silt. An unknown factor from the information reviewed is the chemical content of the deposits. As the present material is being used without apparent problems, neither the deleterious materials nor the chemical content appear to be limitations which cannot be overcome. If tne level of dredging were to be increased, these matters would require further consideration.

From the information available from the Canada Centre For Inland Waters (CCIW), it appears that a significant part of the Niagara River mouth deposit beyond the licensed area may provide similar material to that obtained in the licensed area. If this is true, the remaining areas could be expected to produce similar products. Results from work done by CCIW indicate that, in the area of the Niagara River mouth deposit, the gravel content is less than 10% throughout. This would indicate that dredging could not be expected to supply either Granular or Coarse Aggregates.

Between 120 million and 180 millions tons of sand and gravel are available in the entire Niagara River Mouth Deposit but the amount of material available on the Canadian side of the deposit cannot be estimated because of problems in defining the extent of the deposits. Additional research is required.

The present material being produced is competitive with material from land-based sources. For example, the published prices quoted for mortar sand are about $5.50 per ton from Fonthill and only $4.80 per ton from the dredger. For concrete sand, Fonthill prices are around $4.65 per ton and the dredger's prices are $4.80 per ton. All prices quoted are at the gate prices. These prices indicate that the present dredging operation is competitive.

The current dredging operation has a capacity of about 200,000 tons annually and could not produce all of the Fine Aggregate required to meet Niagara's demand. For dredging to fill Niagara's demand, additional capital expenditures would be required for dredging equipment and land-based storage. The economic feasibility of such investments and the impact of the investments on selling prices is not presently known.

From the information available, it appears that Lake Erie deposits may only provide material suitable as sand fill whereas the Niagara River mouth deposit appears suitable for a range of Fine Aggregate products. Additional information on the quantity and quality of the lake deposits and the economic feasibility of increased dredging would be required before dredging's potential contributions to meeting Niagara's needs can be fully assessed.

4.4 Substitution from Existing Quarries

Niagara's mineral aggregate industry is primarily composed of two parts, sand and gravel, and stone. These two components are both interdependent and competitive. In this subsection, three main subjects will be considered.

1) the existing quarry industry - its production and its potential;

2) the degree of substitution occurring today; and

3) a more detailed review of existing and possible substitution on a product basis of material from quarries for material from pits.

4.4.1 Existing Quarries

In the Niagara Region there are ten licensed quarries which produce about 4,954,000 tons annually. The comparison of the annual production of sand and gravel and stone is shown on Table 4.5. The figures clearly show that quarry production is about 76% of total mineral aggregate production for the Region. Within their licensed areas the quarries are estimated to have between 250 to 325 million tons of reserves. Possible reserves of stone beyond the licensed areas are considerably greater and are estimated at about 11.3 billion tons (1974). The primary locations of the resource are along the Niagara and Onondaga Escarpment at the northern and southern edges of Niagara respectively. (See Figure 2.2)

Table 4.5

Total Mineral Aggregate Production in Niagara 1972 - 1979
(in thousands of tons)

Year	Crushed Stone	Sand and Gravel	Dredging	Total
1972	5,065.5	2,090.4	162.0	7,317.9
1973	5,196.9	1,710.4	350.8	7,258.1
1974	5,319.8	1,691.8	195.0	7,206.6
1975	5,078.6	1,093.6	167.6	6,339.8
1976	4,989.3	1,309.4	143.3	6,442.0
1977	4,513.3	1,016.3	78.8	5,608.4
1978	4,762.1	1,058.1	99.5	5,919.7
1979	4,706.1	933.5	109.5	5,749.1
Average	4,954.0 (76.4%)	1,362.9 (21.0%)	163.3 (2.5%)	6,480.2 (100.0%)*

*Note: Percentages do not add to 100% due to rounding.

Source: Regional Municipality of Niagara Survey of Aggregate Producers, 1980 and Ministry of Natural Resources, 1980/1981.

4.4.2 Existing Substitution

In order to determine the degree of existing substitution it is necessary to compare Niagara to other areas. As shown in Figure 4.2, the split of mineral aggregate production versus sand and gravel in Ontario and Niagara are almost completely opposite. In terms of mineral aggregate production in Ontario, stone represents only 30% and sand and gravel represents 70% while in Niagara, the production of stone is dominant representing about 74% of total production and sand and gravel 26%. These figures in themselves do not necessarily indicate a degree of substitution but do provide a first indication of possible substitution.

A study done by the Ministry of Transportation and Communications (M.T.C.) of Central Ontario aggregate consumption in road construction provides additional information on the topic. These figures are particularly significant as more aggregate is consumed in road construction than in any other use. For their entire Central Ontario study area, it was estimated that about 67% of the aggregate consumed in road construction was from sand and gravel pits and 33% was from quarries. In the breakdown for Niagara, M.T.C. estimated that 90% of the aggregate used was from quarries and only 10% from pits. These percentages are significantly different than the figures for the entire study area and indicate a high degree of substitution of stone products for sand and gravel in road construction and maintenance.

The results of the M.T.C. survey are confirmed by Regional Niagara's own survey of mineral aggregate use by municipalities. Of the mineral aggregate used by municipalities, only about 14% was from pits and 86% was produced from quarries. Because of the record keeping systems and the contracting out of works, not all aggregate used on municipal projects could be either identified or classified. It is believed that despite these limitations, the above figures do provide a relative indication of the use of aggregate from the two sources considered. The high percentage of stone products used clearly indicates that stone products are suitable for the required uses in municipal construction and maintenance.

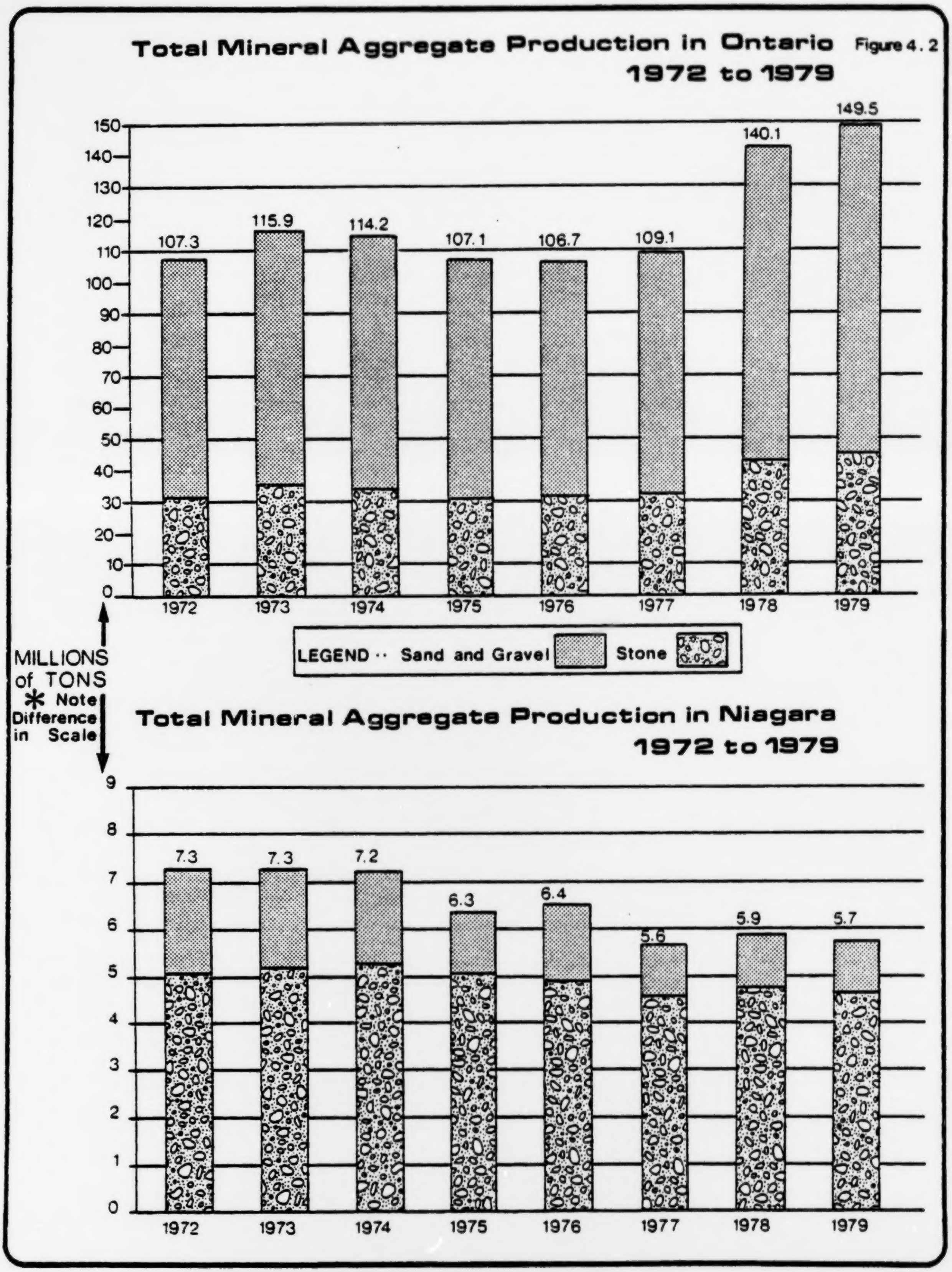
4.4.3 Substitution - By Product Type

As well as considering the question of substitutability on a general basis, it is also necessary to consider it on the basis of the products being produced.

From the Users Guide to Construction Aggregate, attached as Appendix 5, there are two particular categories of mineral aggregate which are of interest.

1) Granular Aggregate for road bases and sub-bases; and,

2) Fine Aggregate for concrete and asphalt products, concrete block and ice control.



Total Mineral Aggregate Production in Ontario 1972 to 1979 Figure 4.2

Total Mineral Aggregate Production in Niagara 1972 to 1979

For both of these categories, the note related to the tables of the Users Guide identify both pits and quarries as possible sources of the materials. This indicates that quarry material can be considered as a possible substitute.

For the granular group, the results of Regional Niagara's survey of municipal use of aggregates showed that about 90% of the granular material purchased in 1979, came from quarries and about ten percent from pits. These figures together with the M.T.C. figures clearly indicate that quarries are currently an alternative to pits for this type of material. The quarried material is a high percentage of use despite the ten to twenty-five percent higher cost of their product. It should be noted that some local engineers specifically mentioned that they prefer quarries material for granular products. In terms of suitability, it is clear that further substitution could occur if either economic conditions were right or granular materials from pits were unavailable.

Fine Aggregate is required as an input to a wide range of products including Portland Cement Concrete, concrete block, masonry mortar, asphaltic concrete and for ice control. At one time, pits would have been the primary source of Fine Aggregate but recently there have been changes. For example, the concrete block manufacturers who responded to the Region's survey purchased over 50% of their Fine Aggregate in the form of manufactured sand. Two quarries in the Region are producing Fine Aggregate in the form of artificial or manufactured sand which now represents between ten and fifteen percent of total sand and gravel production from pits. In Niagara this change has occurred in the past eight years. At this time, there are at least two additional quarries which are evaluating the possibility of producing manufactured sand.

At the present time, manufactured sands are being used in asphalt and concrete products, concrete blocks and for ice control.

The consideration of manufactured sand as an alternative to naturally occurring sand is probably the most difficult to evaluate. Three particular factors require consideration:

1) availability;

2) suitability; and

3) costs.

Given the large stone resources of the Region, the potential supply of manufactured sand is large. At the present time, none of the quarries producing manufactured sand have additional crushers to process stone directly into manufactured sand. Manufactured sand is a by-product produced using screenings which are generally both crushed and washed. If Coarse Aggregate for concrete as asphalt stone is produced more screenings are produced than if granular material is being produced. With more screenings, more manufactured sand can be produced.

There are four possible problems which may limit the use of manufactured sands:

1) the difficulty of getting smooth surfaces because of the angular nature of the sand;

2) the need to use more cement for strength;

3) the possible reduced life of pavements made from the combination of Coarse and Fine Aggregate from the same source; and

4) the "caking" of the sand in some uses.

As manufactured sand is produced by crushing, the sand tends to be angular as opposed to being rounded as natural sand is. This may cause particular problems in concrete pavements. The angularity makes it difficult to produce a smooth finished surface and the material is harder to work.

For Portland Cement Concrete a special allowance has been made in the specifications for manufactured sand which indicates it may be suitable despite these problems. From discussions with both producers and users, there is not a concensus on the use of manufactured sand in Portland Cement Concrete. From the Region's survey of aggregate users, only about 8% of the Fine Aggregate in ready mix concrete comes from manufactured sand. It would appear at this time that if there is to be some substitution of manufacutred sand for natural sand it would be a blend of the two products with at least three quarters being natural sand. At this point, these comments must be considered quite tentative as additional testing is required.

One of the aggregate users in the Region's survey identified the problem of lack of strength in concrete produced using manufactured sand. In order to overcome this problem, the amount of cement required must be greatly increased to meet the specified strength of concrete. This problem was not mentioned by other users and it may be that the degree of substitution of manufactured sand for natural sand may be limited to some specialized uses.

It has been suggested that pavement life may be reduced if both Fine and Coarse Aggregate come from the same parent material. Since natural sand is harder than limestone, when the two are combined, they wear at different rates providing longer pavement life. If both of the inputs to a pavement material are produced from softer limestone then the pavement is expected to have a shorter life. It has also been suggested that the uniform wearing of a pavement surface may reduce skid resistance. Both of these subjects are matters of some debate, and there seems to be varied opinions.

The problem of the "caking" of manufactured sand when used for Ice Control has also been identified. This problem was particularly identified by the Town of Grimsby where,with the "caking", extra costs are incurred in cleaning the streets in the spring. Of the winter sand used in 1979, by the local municipalities and Regional Niagara, 38% was manufactured sand, 12% was from dredging and 50% was from land based pits.As the manufactured sand is being so widely used, and the "caking" does not reduce the effectiveness of the manufactured sand, it would appear that caking is more of a nuisance than a serious problem.

Manufactured sand is relatively expensive when compared to natural sands because of the additional processing needed to produce it. Despite the additional costs, the use of the material in a variety of products such as asphalt products, concrete blocks and winter sand indicates that it can compete in Niagara. It has been reported that manufactured sand at the gate is between 10% and 20% more expensive than natural sand products. The ability of the manufactured sand to compete may then be explained as a function of the location of the quarries closer to the market demand than existing pits. As such, despite the higher production costs, the delivered selling price is competitive.

In summary, manufactured sand is now being substituted for natural sands in asphalt products, concrete blocks and winter sand but not for concrete. If no local supplies of natural sand were available, it would likely be necessary to import natural sand because to make concrete out of only manufactured sands would not produce an acceptable surface. There may be some opportunities to substitute additional manufactured sand in other products but this appears to be a question of economics rather than suitability.

4.5 Substitution By Industrial Waste Products

Industrial by-products are currently being used as substitutes for mineral aggregate. Materials such as slag, fly ash, foundry sands, and re-cycled pavements are all possible substitutes which may be available in or near Niagara. As with natural aggregates, because they are relatively low valued, transportation costs are very significant in limiting the area where substitutes can be used competitively. If there were no natural aggregates available, the concern with transportation costs would be a less significant factor in reducing the market area.

Blast furnace and steel making slag are two forms of slag available as substitutes. Blast furnace slag can be processed to make materials suitable for lightweight aggregate, for cement uses and for a variety of road construction uses. Steel making slag is suitable for use with asphalt for use in road surfaces. In all of these uses, slag is a suitable substitute for coarse aggregate. Both steel making and blast furnace slag are available in Hamilton from the production of STELCO and DOFASCO. This material is used primarily in the Hamilton-Toronto area and little or none has been used in Niagara.

From the former Algoma Steel plant in Port Colborne, air-cooled iron blast furnace slag is available. The amount of slag available is not known but there is a considerable volume. The material has been approved for use on M.T.C. contracts as granular and sub-base material. The material may also be suitable for asphalt and concrete uses subject to testing. The material is used in the Fort Erie, Welland, Port Colborne area by local contractors for a variety of uses including fill and parking lot bases. The material was also used by the St. Lawrence Seaway Authority as granular base on its roads for the Welland By-Pass Channel.

The availability and suitability of slag from Union Carbide and Atlas Steel has also been investigated. Although slag from Union Carbide was once on an approved M.T.C. Source List for Aggregate it was later removed. The Atlas Steel slag has never been approved for use as aggregate substitute. The Union Carbide slag was tested for use as Granular material but it was found to contain too many heavy metals which limits its use to dry sites. The St. Lawrence Seaway Authority did use some as fill material in conjunction with the Welland Canal By-pass in protected areas. It may be possible to use this slag as fill in other projects but this particular slag would not appear to be a major substitute for sand and gravel.

Fly ash is another potential substitute for sand fill. Fly ash is a by-product of the burning of coal at Ontario Hydro's thermal generating stations. It has been used in the past primarily as fill in reclamation projects but has recently been used as structural fill on some highway projects in southwestern Ontario. Fly ash can also be pelletized and used as a lightweight aggregate in the production of lightweight blocks and concrete beams. For these uses it would be replacing Fine Aggregate from pits or manufactured sand.

The closest location where this material may be available would be the Nanticoke Generating Station, a distance of about 50 miles from St. Catharines. The fly ash is current unavailable as it is being used as fill at Stelco's Nanticoke site. At this time, a haul of approximately 50 miles would make the use of this material uneconomic in Niagara if used as sand fill because sand fill sells for between $1.00 to a $1.50 per ton. To transport the material 50 miles by truck would cost about $3.50, for transportation alone. In the future, it might be competitive for specialized uses but the amount consumed would be small.

The re-cycling of foundry sand is another possible substitute for sand and gravel. General Motors imports special sand from Michigan to use in their foundaries in St. Catharines. After it has been used, it is stockpiled by a Walker Brothers company for re-sale as sand fill. As the material contains wastes from the foundry process, it is not possible to use the material in a roadway in which metal conduits or reinforcing rods will be used because of the corrosive nature of the wastes. The material has been used as structural fill in an enclosed clay tomb on some bridge approaches on Highway 406 in St. Catharines. About 125,000 tons of waste sand is produced annually. To date, there has been limited use of the material because of the potential environmental problems. In the future General Motors may begin re-cycling the material and thus this material may not be available.

The re-cycling of asphalt pavements is another alternative to be considered. By re-cycling asphalt pavements, aggregate needs can be reduced by over 10%. The practice of re-cycling is increasing and may somewhat reduce the need for both Fine and Coarse Aggregates for asphalt (eg. Q.E.W. - Ford Drive Interchange at Oakville).

4.6 Other Building Products

Another possibility is the substitution of other building materials (e.g. steel and clay products) for products made from sand and gravel. However, less than 20% of sand and gravel is used indirectly. The current building technologies allow some degree of substitutability but there are no indications of major changes. In cases of substitution, the primary considerations are customer preference and economic factors. Over time the economic factors may change but these are not possible to predict. It is also possible that products made from sand and gravel will actually substitute for other building materials. Even if there was a significant shift, the impact on overall demand would be relatively small since only about 20% of all sand and gravel is used for these purposes. Thus a 10% shift in consumption in this area would result in only a 2% change in overall consumption of aggregate.

4.7 Summary

In this chapter, a wide range of alternatives have been reviewed. Assuming that material could be purchased in other areas of Ontario, it would appear that there would be a price increase to the consumers in Niagara. The degree of the price increase would be dependent on the value of the product being imported, the mode of

transportation use and the length of the haul. If the material were imported from the Brantford-Paris area, the increase in cost if the material were hauled by truck would range between 60% to 249% depending on the current selling price. If the same material were imported by rail in bulk, the cost increases would range from about 30% to 132% exclusive of any additional capital costs for railway equipment.
It must also be noted that all of these transportation costs are subject to significant escalation in the future as Canadian energy prices rise closer to world levels. If the Regional community was prepared to pay the additional costs, then importing could be considered.

Table 4.6 summarizes the findings concerning the use of different materials or materials from different sources.

Table 4.6

POSSIBLE SOURCES OF SUBSTITUTION FOR PIT MATERIALS AND THEIR USE

Substitute	Material	Type of Aggregate It Replaces	Possible Uses	Remarks
Dredging	Sand and Gravelly Sand	Fine Aggregate	- Concrete, mortar & winter sands	- Material available locally at competitive prices from existing operation
Quarries	Stone	Granular	- Road bases & sub bases	- Presently being used in significant volumes
		Fine Aggregate	- Asphalt & winter sands	- Presently being used, possibility for expanded use
			- partial replacement of concrete sand	- limited expansion possibilities
Waste Products	Slag	Granular	- Road bases & sub-bases	- Limited use which could be expanded
		Fill	- Fill	- Not a major concern
	Fly Ash	Fill	- Fill	- Not likely economically attractive
		Fine Aggregate	- Concrete Block	- Specialized use for light weight blocks
	Foundry Sand	Fill	- Fill	- Not a major concern

As can be seen from the material presented in Table 4.6 there already is a degree of substitution. In terms of granular material, about 90% of this material is already produced by quarries. In terms of Fine Aggregate production it is estimated that about 15% is produced by quarries, 15% by dredging and the remainder from pits. Within the Fine Aggregate category, there are wide variations in the degree of substitution. For three particular products, the present degree of substitution is shown in Table 4.7.

Table 4.7

SOURCES OF FINE AGGREGATE
FOR SELECTED PRODUCTS

Product	% of Material from Various Sources		
	Land Based Pits	Quarries	Dredging
Concrete Sand Used in Ready-Mix	90	8	2
Winter Sand	50	38	12
Fine Aggregate for Concrete Block Manufacturing	20	52	28

Source: Regional Niagara Survey of Aggregate Users 1980.

There would appear to be some scope for additional substitution in the area of winter sand and concrete sand, although in the case of concrete sand there would appear to be limits on the degree of substitution possible and any substitution may be primarily dredged material.

Although some industrial by-products are available locally, due to a number of factors neither the iron blast furnace slag nor the waste foundry sands has been used extensively. In the future, it is possible that the use of waste by-products may become more important but in the past such substitution has been for lower value products such as for fill and Granular A. At this time, there are not substitutes available from industrial by-products for Fine Aggregates used in Portland Cement concrete and asphaltic concrete products.

Although some changes in the pattern of use of different building products may occur, their impact on the demand for sand and gravel would be very small. These changes are not considered significant for this study.

Chapter 5

DEMAND*

What will be the future demand for mineral aggregates in the Niagara Region? This is an important question as mineral aggregates are a basic component in a variety of construction projects from roads and sewage treatment plants to offices and houses. It is also a difficult question since the demand for mineral aggregates largely is linked to the types and amounts of government and private investments in construction. Such investments are affected by the state of the economy and occur in an uneven geographic distribution.

Through the period of rapid growth in Southern Ontario, the annual demand for mineral aggregates grew from 6 tons per capita in the late 1940s to 15 tons or more per capita in the early 1970s. This led to an increasing number of new or expanding pits and quarries. At the same time, urban-type uses were spreading outward from urban centres sometimes building over sand and gravel deposits. The combined effect of these developments on Southern Ontario's landscape caused growing competition among land uses, environmental concerns, and, among other things, increased interest in planning for and in regulating the further growth of mineral aggregate extraction.

During the second half of the 1960s the predecessor of the Ministry of Natural Resources initiated a series of studies dealing with mineral aggregate supply and demand. These studies serve as a starting point for considering Niagara's future demand. It is the approach and limitations which merit consideration rather than the projections themselves since they have been affected by changing economic conditions. By combining the benefits from this earlier work with more recent economic information, Niagara's requirement for mineral aggregates are projected to 1996. The concluding section compares this projection with recent projections by the Ministry of Natural Resources.

5.1 Projecting Demand for Mineral Aggregates

Three studies are considered here all involving the Ministry of Natural Resources:

- the 1974 Mineral Aggregate Study: Central Ontario Planning Region by Proctor and Redfern Limited
- the 1976 Policy for Mineral Aggregate Resource Management in Ontario by the Ontario Mineral Aggregate Working Party.

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* Emrik H. Suichies and Associates contributed material for this Chapter.

- the 1977 Mineral Aggregate Study and and Geological Inventory Southwestern Region of Ontario by Proctor and Redfern Limited and Gartner Lee Associates Limited.

The first study of the Central Ontario Planning Region is of interest here as it includes the Niagara Region within a much larger area but, more importantly, sets out a method of predicting aggregate demand. This method subsequently was used in two similar regional studies of Eastern and Southwestern Ontario sponsored by the Ministry of Natural Resources. The Mineral Aggregate Working Party reviewed this method.

5.1.1 Projection Method Based on Construction Values

In the Central Ontario Study, a method was developed that related the production of aggregates to the value of construction. Two key points in this method are determining the value of construction and then converting this value into the amount of aggregate required.

Value of construction was seen to have a relatively constant relationship with the Gross Provincial Product (GPP). Assuming this relationship would hold, projection of the GPP over a period of years would yield estimates of the value of construction.

The projected value of construction was converted to mineral aggregate requirements through four "input factors" related to four major construction categories. These input factors enable a recognition for example, that residential construction uses less aggregate than road construction. As well, they enable demand projections to be somewhat sensitive to possible changes in the mixture of construction activities.

The four input factors for 1971 and construction categories are:

a) residential - 4.36 tons of aggregate per $1,000 of construction

b) non-residential - 7.87 tons of aggregate per $1,000 of construction

c) road engineering - 122.85 tons of aggregate per $1,000 of construction

d) non-road engineering - 15.47 tons of aggregate per $1,000 of construction

The value of construction is in 1971 dollars so that $1,000 then is equivalent to about $2,045 in 1979.

Data are readily available on the value of construction for the four major construction categories. This permitted study of the relationship between, say, residential construction to the total value of construction over a period of years. This could then form the basis for assumptions about the mixture of the four categories in future years.

When this was done, the projection method worked as follows:

a) project the Gross Provincial Product over a period of years into the future (in constant 1971 dollars);

b) project the value of construction (GPP x constant percentage);

c) establish the proportion of the construction value to be represented by each of the four major construction categories; and

d) multiply the construction value for each of the four categories by the "input factor" for each year within the forecast period. This results in mineral aggregate tonnages.

The development of this method was a noteworthy advance in estimating the future demand for aggregates and raised interest in the future availability of the resource.

5.1.2 Limitations of the Construction Value Approach

Two limitations to the method described above are (1) unexpected changes over the projection period in the economy and (2) distribution of demand. On the first point, if the projection of the GPP was accurate, the relationship between the value of construction and the GPP remained relatively constant, and the mix of construction activities among the four categories remained as assumed, the resulting projection of requirements should be close to the actual demand for aggregates. These are big ifs. Moreover, the four input factors, tonnage of aggregate per $1,000 of construction, are assumed to remain unchanged.

In 1976, the Mineral Aggregate Working Party undertook to review the projection method developed in the Central Ontario Study. They concluded that a 25 percent reduction from the projections in the Central Ontario Study was their "best guess" as to the future demand for aggregates. The 1977 Southwestern Study had a 14% reduction from the project 2001 cumulative demand in Ontario for mineral aggregates stated in the Central Ontario Study.

At least of equal importance in order to understand the future demand in Niagara concerns the second point on distribution. How much of the mineral aggregate projected for the Province as a whole will be required in Niagara? In the Central Ontario Study, a proportion of Provincial demand is allocated to the Central Ontario region on the basis of relative population and population growth rates. This assumes a close relationship between the distribution of population and the amount and type of construction and thus aggregate requirements. This is not necessarily valid. For instance, in the Sudbury Region, the requirement for mineral aggregate was actually many times higher than was indicated by the size of the population. The use of large amounts of aggregate as backfill in the mines was found to be the reason for the discrepancy.

An interesting footnote to the above discussion concerns the type and amount of aggregate required i.e. sand and gravel or crushed stone. The Central Ontario Study estimated for three major centres in the Niagara Region that the existing and projected requirements were about three parts sand and gravel to one part crushed stone. In fact, the reverse is true as described previously in Chapter 2.

5.2 Niagara's Requirements for Mineral Aggregate

Since the demand for aggregates is linked to economic activity, an analysis of the Niagara Region's economy and its likely development over the next 10 to 15 years offers an alternative method for determining the future requirements for mineral aggregates. This method allows for more careful consideration of the particular characteristics of Niagara while lessening the likelihood of being influenced by projections made on a provincial or subprovincial basis. Greater validity is added to this method when it is recognized that very little aggregate is imported into the Niagara Region while most of the exports are from a quarry in Port Colborne to the United States.

This section begins by comparing recent economic development with an overview of economic projects to 1996. The construction activity during the 1970s is reviewed as assistance in preparing the demand for mineral aggregates over the next 15 years by the four construction categories; road engineering, residential, non-residential, and non-road engineering.

5.2.1 Economic Activity: An Overview

The Niagara Region's favourable location adjacent to North America's major market areas, good transportation facilities (rail, road, and water), a highly skilled labour force, and favourable electric power rates contributed to considerable economic growth during the first half of this century. Manufacturing, in particular, became an important sector employing close to half of the Region's labour force by 1951.

As documented in Trends in the Niagara Regional Economy: 1961 to 1978*, important changes have taken place in Niagara's economy since that time.

The 1950s through the 1960s to the first part of the 1970s was a period of active economic expansion, and of strong population growth. Major additions were made to the transportation system, urban growth and industrial development for example. Investments were made in educational institutions such as a new university and community college. Government was concerned primarily with building and maintaining roads, schools, services, etc. and was generally trying to stay ahead of the requirements of a rapidly expanding economy.

These conditions, compared to more recent experience, appear like the "good old days". Recent development exhibits the following characteristics to name a few:

- a slow down in population growth and an overall aging of the population;
- a decline in the relative significance (as employers) of manufacturing in Niagara's economy.**
- other goods producing sectors - agriculture and construction - also have seen their relative importance (as employers) decline.
- strong gains in employment in the service sector which includes finance, trade, education and health services, consulting, and a wide variety of personal services.

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* Regional Municipality of Niagara, Planning and Development Department, February, 1979.

** See Trends in the Niagara Economy, table 10.

The question is, of course, how much further will the Region's economy move in the direction of an economy where more jobs are provided by the service sectors than in the goods producing sectors? A study by the Ministry of Treasury and Economics* suggests that, by the end of the century, approximately 75 percent of the labour force in the Province as a whole will be employed in services, and no more than 25 percent in goods production. It is probable that the Niagara economy will follow this trend at least during the next 15 years.

There are a number of important reasons for this. The manufacturing sector throughout the Province, and particularly in areas where industry established early and operates from older facilities, is experiencing a period of adjustment and re-development. The need for adjustments was hastened by the energy crisis and by tariff agreements. On the other hand, the urgency for adjustment was softened somewhat by the weakening of the Canadian dollar against other currencies.

The objectives of these adjustments is to improve the competitive position of the plants concerned on national and international markets. This is achieved by increasing the productivity of the plant by reducing production costs (both fixed and variable) per item produced. This can be done by either increasing the number of items produced from the same plant and work force, or by keeping production more or less steady and reduce production costs (including labour).

In the first case (expansion of production) employment does not increase. In the second case, employment may be reduced. Niagara is likely to experience its share of employment reductions in existing manufacturing plants over the next two decades. Attraction of new plants is becoming more and more difficult as competition has sharpened considerably within the country, and as many low wage countries are attracting an increasing share of the world's manufacturing capacity.

The prospects for the manufacturing sector would appear to be that it would do well if it could hold on to its present labour force within the Region. The other goods producing sectors (agriculture and construction) are likely to experience a similar trend. Employment in agriculture is not likely to decline much below current levels unless this industry's key productive resource (land) is further reduced. Employment in construction is also likely to remain close to current levels at least during the 1980s when most of the need for housing by the members of the "baby boom" will be felt. The need for major investments in large construction projects such as highways, bridges and tunnels, power stations, canal widenings, etc. is expected to be limited.

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* Treasury and Economics - Long Term Economic Outlook for Ontario, June, 1976.

This leaves the service providing sectors. As is pointed out in the 1979 study on the regional economy during the last two decades, Niagara has been successful in creating jobs at a rate higher than the rate of population growth. Almost all of these new jobs were added in the service sectors, particularly in the community, business and personal services sector. During the 1980s, it is likely that the labour force will continue to grow faster than the population. This is due to the arrival of the majority of the members of the baby boom on the job market.

The job opportunities for these young people will probably be more limited than they were, say, in 1975. The education, health and public service sectors have been subject to spending restraints for several years. These restraints are likely to be with us for several years to come. Although they will not limit new job creation in these sectors altogether, they must be expected to put a damper on employment prospects in these activities.

On the other hand, job creation in the personal services field is likely to be buoyant. A recent analysis of the tourism industry in Niagara Falls, for example, estimated that this industry is underperforming at the present time, and should be able to double its employment over the next 10 years.*

Similarly, the increased trend towards revitalizing downtown areas with its emphasis on strengthening the role of the independent retailer promises increases in employment in the trade sector. The finance, insurance and real estate sector is also expected to do well, while the transportation sector is expected to hold its ground over the next two decades.

These considerations indicate that, at least in the medium term, the Region's economy is likely to generally follow the growth pattern predicted for the provincial economy, and move to what has been referred to by Daniel Bell** as the post-industrial society. This society will be characterized by an economy concerned with the provision of services

a) to residents (education, health care, food and beverages, retail and wholesale services etc.);

b) to visitors (accommodation, food and beverages, amusement and recreation, retail and wholesale services, etc.); and

c) to business.

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* See for example Lanmer-Fenco: City of Niagara Falls Tourist Area Traffic and Parking Study - Interim Report on the Data Collection, December, 1980.

** Daniel Bell: The Post Industrial Society.

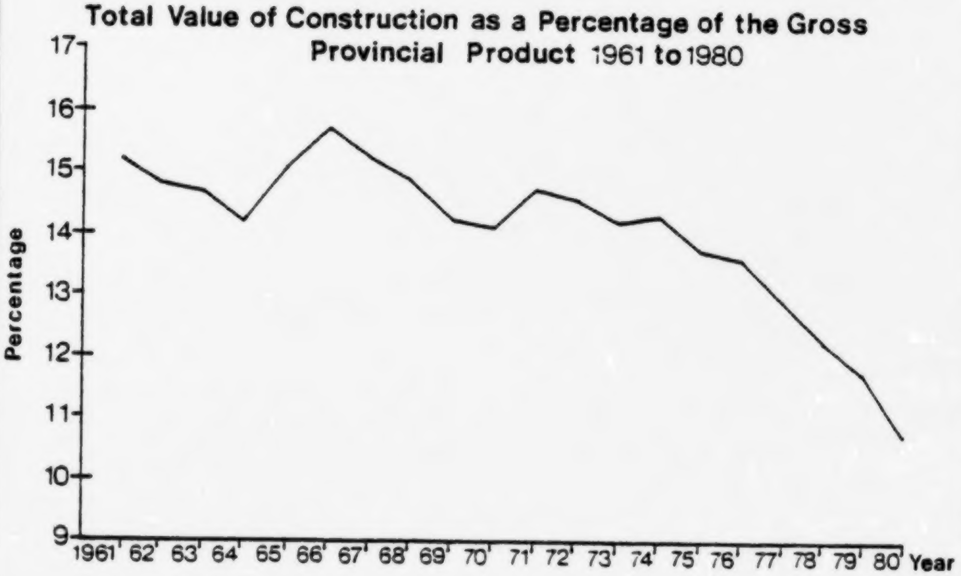
This economic development may be expected to parallel the emergence of an aging population that will demonstrate an increasing reliance on a variety of services, particularly in the field of health care, but also in the field of personal services.

5.2.2 Construction Activity

The above overview of economic activity may serve as general background to an assessment of probable construction activity within the Region, and the resulting demand for mineral aggregate. As shown in Figure 5.1 the value of construction work performed in the Province as a whole represented a significant and relatively steady proportion of the Gross Provincial Product (GPP) during the 1960s. In the last decade, this proportion has declined steadily, without interruption, to a level of approximately 11 percent (from 14.52 percent in 1971).

Figure 5.1

Total Value of Construction as a Percentage of the Gross Provincial Product 1961 to 1980



The only explanation for this decline would appear to be a gradual re-allocation of expenditures by government. Government projects, according to a recent study carried out for the Aggregate Producers Association of Ontario, are responsible for 80 percent of total consumption of mineral aggregate*. Road engineering projects alone were calculated to require approximately 50 percent of total consumption in 1971, and non-road engineering construction projects (such as water works, sewage systems, electric power installations, etc.) a further 29 percent. Residential and non-residential building construction required the remaining 21 percent. Part of this construction such as schools, hospitals, and senior citizen residences are also public sector projects.

The only significance of these statistics is that they help to explain the ups and downs of mineral aggregate consumption in the Region. It is obvious that the level of road building work going on in an area is very important in determining the requirement for sand, gravel and crushed stone. If there is an increase or a decline in road work, the tonnages consumed may be expected to vary significantly. Major infrastructure projects, such as water and sewer construction works, power stations and the like occur only from time to time and may also have significant effects on variations in demand. Other construction activities, such as residential, commercial, institutional, industrial and other building projects are more frequent and more evenly divided over time and probably account for a relatively steady demand for mineral aggregate.

Provincial expenditures on roads represented almost 9.25 percent of gross provincial expenditures in 1971**. This proportion has declined steadily throughout the decade to a level of 5.17 percent by 1979***. This decline was not balanced by increases in municipal road expenditures. In fact, Ontario's municipalities, on average, kept this item in their budgets close to 11 percent throughout the decade*. As shown in Figure 5.2, road expenditures in the Niagara Region have been somewhat above this average.

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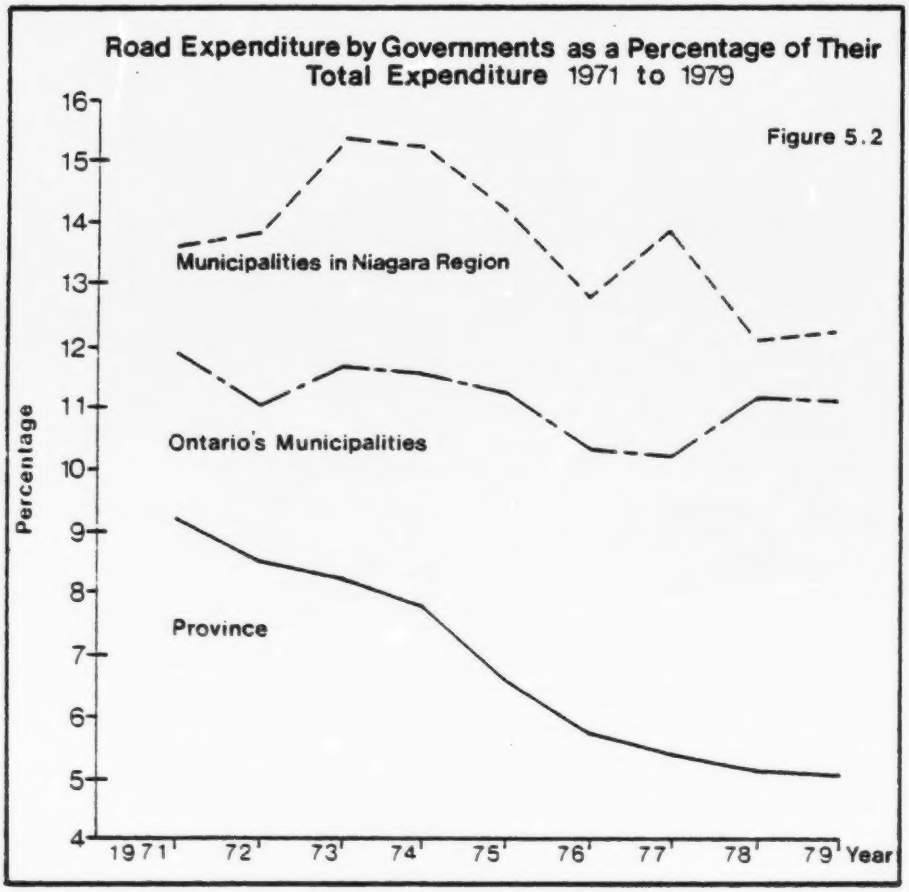
* G.M. Stamm, A Study of the Economic Impact on the Mineral Aggregate Industry of the Proposed Plan for the Niagara Escarpment, A report for the Aggregate Producers Association of Ontario, 1980, p.4.

** including bridges, tunnels, new construction and maintenance.

*** Statistics Canada 68-207 Provincial Government Finance.



Road Expenditure by Governments as a Percentage of Their Total Expenditure 1971 to 1979

Figure 5.2

Data on provincial road-related expenditures within Niagara are not readily available. However, because the Province cost-shares a major portion of the road building and maintenance activities, the amount of municipal expenditures for road building and maintenance may serve as a general measure of actual provincial road expenditures within Niagara. This assumption is judged to be valid over the longer term, actual provincial expenditures may vary significantly from year to year. On this basis, total road construction and maintenance expenditures may be calculated, as shown in Table 5.1. The data presented in Table 5.1 are in constant 1971 dollars to eliminate the effects of inflation.

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* Statistics Canada 69-204 Local Government Finance.

As road construction and maintenance are responsible for approximately 59 percent of mineral aggregate consumption, the decline in expenditures on this item may be seen as an important reason for the decline in production of the material within the Region during the 1970s.

Table 5.1

Road Construction and Maintenance
Expenditure Estimates, Niagara Region
1971 - 1979

In constant 1971 dollars

	Municipal Expenditures	Provincial Expenditures	Total Expenditures
	($000,000)	($000,000)	($000,000)
1971	22.4	26.9	49.3
1972	21.0	21.9	42.9
1973	25.3	29.8	55.1
1974	21.2	25.9	47.1
1975	23.2	24.3	47.5
1976	21.0	20.7	41.7
1977	21.3	19.7	41.0
1978	20.1	17.1	37.2
1979	20.5	17.3	37.8

Data on the value of non-road engineering works** are available only for the Province as a whole. As shown in Figure 5.3, real expenditures on non-road engineering in Ontario have remained relatively stable during the last 10 years. Expenditures on waterworks, sewage systems and related environmental construction represents an important component on non-road engineering construction expenditures. The information available on expenditures on this item in Niagara (Table 5.2) generally confirms the no-growth trend in real expenditures on non-road engineering during the 1970s, and indicates that this trend is valid for the Region as well.

** Waterworks, sewage systems, dams and irrigation, electric power construction, railway, telephone and telegraph, gas and oil facilities, marine construction and other engineering construction.

Table 5.2

Pollution Control, Water Purification and Supply and Other Environmental Cost Estimates, Niagara Region 1971 - 1979

	In constant 1971 dollars		
	Municipal Expenditures	Provincial Expenditures*	Total Expenditures
	($000,000)	($000,000)	($000,000)
1971	17.1	17.3	34.4
1972	15.2	15.4	30.6
1973	19.5	19.6	39.1
1974	21.9	21.9	43.8
1975	20.6	20.6	41.2
1976	15.3	15.2	30.5
1977	14.9	15.0	29.9
1978	14.4	14.4	28.8
1979	15.1	15.0	30.1

* estimate

Sources: Statistics Canada 68-203, table 11, 68-204, table 2 and 68-207, table 2, and Ontario Statistics 1980, page 373.

Information on the value of residential and non-residential* construction is also available for the Province only. The provincial data show that the value of these forms of construction, after growing significantly during the first part of the 1970s, then stabilized and began to decline. Preliminary figures available for 1980 indicate that the decline recorded in 1979 continued during 1980 (Figure 5.3).

The only information available at the Regional level that may indicate whether or not this trend is valid for Niagara as well is the value of building permits issued by municipalities within the Region. This information is presented in Table 5.3. Although the value of building permits issued may not be reflected in all cases in actual investment in construction, it may be interpreted as intended construction. In this capacity, the permits serve as an indication of residential and non-residential construction activity.

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* including industrial, commercial, institutional and other building construction.

Figure 5.3

Residential, Non-Residential, and Non-Road Engineering Construction Expenditures, Ontario 1971 to 1980
(in constant 1971 dollars)

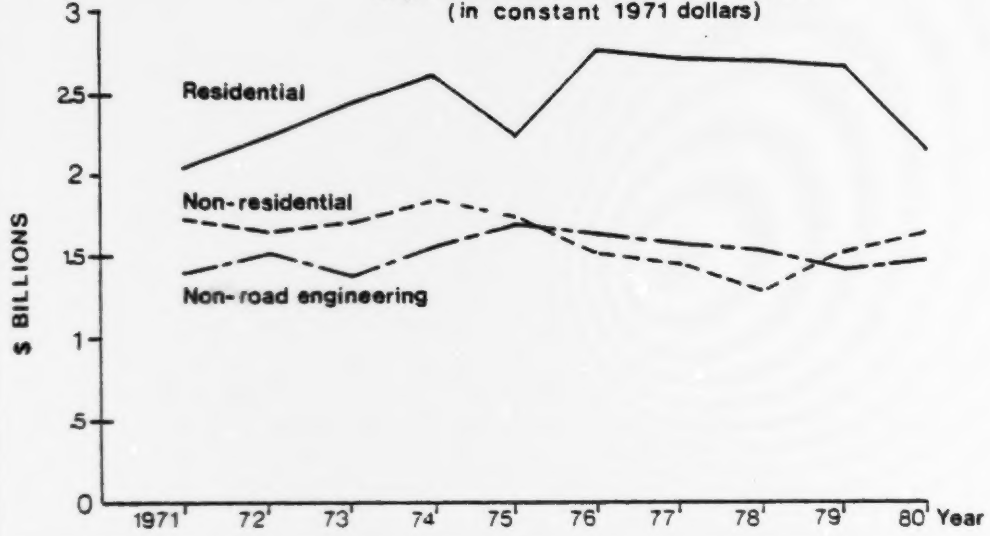

Table 5.3

Value of Residential and Non-Residential Building Permits Issued by Municipalities in the Niagara Region 1971 - 1979

(In constant 1971 dollars)

	Residential Permits		Non-Residential Permits
	($000,000)		($000,000)
1971	N.A.		N.A.
1972	N.A.		N.A.
1973	71.6		52.6
1974	72.5		27.8
1975	75.6		39.1
1976	79.3		32.2
1977	59.2		25.8
1978	50.6		34.1
1979	36.8		36.9
1980	33.6	(Preliminary)	37.2

Source: Regional Municipality of Niagara Finance Department (1976 to 1979 data) and Statistics Canada 64-203, table 7; Ontario Statistics 1980, page 377.

The value of residential building permits issued indicates that this form of construction has declined sharply in the Region during the last decade. This decline is more pronounced in Niagara than it is in the Province as a whole. The value of non-residential building construction in Niagara has generally followed the provincial pattern more closely. Its decline, with exception of low points in 1974 and 1977, has been more moderate.

With real expenditures on all forms of construction down over the last decade, the question would appear to be - what has the money been spent on? Real expenditures by the Provincial Government increased by more than 36.3 percent over the 1971 to 1979 period. As shown in Table 5.4, real expenditures by Ontario municipalities in Niagara, increased at a lower rate.

Table 5.4

Gross Expenditures for Ontario, Municipalities in Ontario and Municipalities in Niagara, 1971 - 1979

(In constant 1971 dollars)

	Ontario	Ontario Municipalities	Municipalities in Niagara
	($000,000)	($000,000)	($000,000)
1971	$6,162	$4,002	$165.6
1972	6,384	4,115	153.2
1973	6,733	4,119	163.9
1974	7,309	4,063	140.8
1975	7,834	4,358	168.0
1976	7,938	4,389	166.7
1977	8,145	4,623	159.6
1978	8,214	4,601	175.2
1979*	8,400	4,600	177.0

* estimates

Source: Statistics Canada 68-203, table 11, 68-204, table 2 and 68-207, table 2.

As noted above, investment by governments in construction projects of various kinds have generally grown at a rate below the inflation rate. This is reflected in the statistics on value of construction in Niagara, and elsewhere.

The expenditures that have shown the strongest growth by municipalities in Niagara* are the items referred to as General Services (including executive and legislative expenditures, administration, pension plan contributions, etc.), Protection of Persons and Property, Health Care, Social Services, and Recreation and Culture. Health Care expenditures, in particular, have shown dynamic growth (amost 23 percent per year in actual dollars). Expenditures on General Services, Protection of Persons and Property, and Recreation and Culture grew at rates between 13.3 and 14.6 percent during the 1970s.

The main losers (in relative terms) were Transportation and Communications, Environment and Education. The share of these items in the context of total municipal expenditures in the Region declined between 1971 and 1979.

At the Provincial level, the expenditure items that grew strongest were General Services, Social Services, Recreation and Culture, and Debt Charges. The losers were Transportation and Communications, Environment and Education. At the federal level, all service related expenditures grew strongly as well.

This brief look at the statistics would indicate that the increases in allocations by governments to a variety of people and property oriented service programs accounts for continued growth in government expenditures. These "soft" services have significantly increased their share of total government expenditures compared to investments in infrastructure and other "hard" services during the last decade.

5.2.3 Demand for Mineral Aggregates in Niagara 1981-1996

The evolution of both employment patterns and investment patterns within the Region in recent years indicates that Niagara has moved in the direction of a service economy. The trends are unmistakable, and may be seen as the beginning of a shift which will continue throughout the forecast period. It is confirmed, for example, by a recent analysis by the Provincial Government of the prospects of the automotive industry in Ontario. This analysis suggests that this industry, which is important in the Region, will not be able to continue to provide the number of jobs it does today. Various forecasts of economic growth to the end of the century, prepared by such agencies as the Economic Council of Canada, the Department of Finance, Ontario Hydro and the Ministry of Treasury and Economics are explicit in their assumptions on the growth in services versus goods production.

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* See Statistics Canada 68-203, table 11 - General Expenditure by Region.

This section deals with the probable effects of changing economic conditions and investment patterns on the demand for mineral aggregate. It approaches this question by assessing the likely development of the value of construction in each of the four main categories identified above. The mineral aggregate "input factors" developed by the Ministry of Natural Resources will then be applied against the projection of value of construction for a calculation of mineral aggregate requirements for each year, and for the forecast period as a whole.

A. Road Engineering

Table 5.1 provides information on annual expenditures on road engineering in the Niagara Region between 1971 and 1979. The amounts included cover all expenditures, including actual engineering work (new construction, re-construction), maintenance, safety provisions, signing, snow clearance, etc. by the Region, the area municipalities and the Province. As noted, the decline in real expenditures on this item is evident.

The five year (1980-84) capital works budget of the Regional Municipality indicates that this decline is expected to continue, at least until 1984. The Region has allocated $43.3 million of capital to road construction over 5 years, or an average of $8.6 million per year (in 1979 dollars). In constant 1971 dollars, this represents an average investment of approximately $4.2 million dollars per year. This appears to be well below the expenditures made by the Regional Municipality, as recorded by the Ministry of Transportation and Communications, between 1975 and 1980* (at an average of $6.2 million per year in 1971 dollars).

Over the period Ministry of Transportation and Communications analyzed road engineering expenditures in Niagara, the regional roads item represented a relatively high proportion of total road engineering work (33 to 37 percent). By 1980, the Ministry expected that this proportion would have declined to approximately 29 percent. If this proportion would be generally valid for the next five years, total capital expenditures by the municipalities in the Region would average $14.5 million per year during the 1980-84 period (including subsidies).

To this amount must be added the direct expenditures by the Province during the 1980-84 period. Details on provincial intentions within the Niagara Region are not readily available . Based on continuation of the current "hold the line" budgets on road engineering, it is estimated that direct provincial expenditures in Niagara will average those made between 1975 and 1980 ($3.9 million).

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* M.T.C. recorded expenditures made by the Regional Municipality on regional roads requiring mineral aggregate. These expenditures include capital expenditures (new roads, reconstruction and repair) and other mineral aggregate requiring activities such as winter sanding.

This brings the total estimated capital investment in road engineering in Niagara to an average of $18.4 million (in 1971 dollars) during 1980. This amount is estimated to represent the average annual mineral aggregate requiring expenditures on road engineering over the 1980-1984 period. Based on the allocation of expenditures as contained in the Region's five year capital works budget, the annual expenditures on road engineering in Niagara during the 1980-84 period may be expected to be as follows:

1980	$18.7 million
1981	$17.4 million
1982	$20.2 million
1983	$14.6 million
1984	$21.1 million

Beyond 1984, no hard data are available to assist in projections of expenditures on road engineering in the Region. The municipalities within the Region, during the 1970s, have permitted this expenditure item to decline somewhat to a level of approximately 12 percent of their total expenditures (from a high of 15.3 percent in 1973*). It is reasonable to assume that the real costs involved in maintaining the existing network of roads, bridges and tunnels, plus the addition of new road segments and reconstruction of existing roads, will cause this level of expenditures to remain at this approximate level during the forecast period.

Other than the St. Catharines sector of Highway 406, which currently is under construction, major additions to the road network in the Region are not foreseen by the Province. Potential work on the southern section of Highway 406, and work on other highways is subject to increasingly tight budget constraints. When it is decided to proceed, the work is likely to be carried out in a manner that phases capital expenditures over a longer period than was the case in the past. The steady decline in provincial expenditures on road engineering (from 9.23 percent of provincial expenditures in 1971 to 5.17 percent in 1979) is expected to continue, but probably at a moderate rate.

When municipal and provincial expenditures are combined, it is probable that the real value of road engineering work during the next decade and a half will continue the pattern of decline established during the 1970s. The average rate of decline may be expected to moderate somewhat from the level experienced between 1971 and 1984 (-2.86 percent per year in real expenditures). For projection purposes it has been assumed that the decline will range between -1.0 percent per year and no further decline between 1985 and 1996. The resulting expenditures (in 1971 dollars) and related mineral aggregate requirements are presented in Table 5.5.

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* See Statistics Canada 68-203, table 11 - General Expenditures by Region.

Table 5.5

Road Engineering Expenditure Projections and Related Mineral Aggregate Requirements, Niagara Region, 1980 - 1996

	Projected Expenditures (in thousands of 1971 dollars)	Estimated Mineral Aggregate Requirement (140.87 tons per $1,000 worth of construction*)
1980	$18,730.0	2,638,417 tons
1981	17,420.0	2,453,955
1982	20,190.0	2,844,165
1983	14,530.0	2,046,841
1984	21,080.0	2,969,540
1985	18,216 to 18,400	2,566,008 to 2,592,008
1986	18,034 to 18,400	2,540,450 to 2,592,008
1987	17,854 to 18,400	2,515,093 to 2,592,008
1988	17,675 to 18,400	2,489,877 to 2,592,008
1989	17,498 to 18,400	2,464,943 to 2,592,008
1990	17,323 to 18,400	2,440,291 to 2,592,008
1991	17,150 to 18,400	2,415,920 to 2,592,008
1992	16,979 to 18,400	2,391,832 to 2,592,008
1993	16,809 to 18,400	2,367,884 to 2,592,008
1994	16,641 to 18,400	2,344,218 to 2,592,008
1995	16,474 to 18,400	2,320,692 to 2,592,008
1996	16,309 to 18,400	2,297,449 to 2,592,008
Cumulative 1981 - 1996 Requirement		39,469,238 to 41,418,597

* Source: Ministry of Transportation and Communications - Construction Expenditures and Demand for Mineral Aggregate Forecast for Road Construction in the Central Ontario Planning Region, 1979 - 1980 (by Regional Municipalities/Counties and Type Municipalities).

The high mineral aggregate tonnage requirements per $1,000 of construction makes projection of road engineering activities of crucial significance in projecting demand for mineral aggregate. Fortunately, the data available permit statistical analysis of road engineering work performed within the Niagara Region. While it is probable that there will be variations in the yearly tonnage requirements presented in Table 5.5 (i.e. in the tonnage figures for the years between 1985 and 1996) the estimates are likely to approximate actual demand when seen as averages. In particular, the cumulative tonnage requirement figure is judged to be representative of the actual requirement for road engineering works by 1996.

B. Residential Building Construction

Data for other forms of construction (non-road engineering, residential, and non-residential construction) are not available for the Niagara Region. It is apparent from the value of residential building permits issued by the municipalities within the Region that investment in this form of construction has declined sharply in recent years (see Table 5.3.) Preliminary data available for 1980 indicate that this was another year of limited activity in the residential construction sector in the Region. Unsold housing inventories remain high, yet rental accommodation vacancies are very low.

Higher interest rates and economic uncertainty make for slow housing sales. The economic outlook for 1981 is one of slow recovery after the recession years of 1979 and 1980, if any. The medium term outlook, to 1985, is somewhat more positive, with the probable return of real economic growth.

An important reason for the more positive medium term outlook is seen in the arrival of young people born during the baby boom years of the Fifties and Sixties, on the labour and consumer markets. Housing will be among the basic requirements of this generation, and some strength may be expected to return to the residential construction sector by the middle of the decade. This means that, even if the total population of the Region would not grow, increased demand for housing may be expected.

In addition, the population of the Region will continue to grow over the 1980 to 1996 period. It is assumed that this rate of growth will be comparable to the rate of growth experienced between 1971 and 1979 (0.7 percent per year). As a result of these conditions, overall growth in real investment in residential construction may be expected to rebound to a level of plus 1 to 2 percent between 1981 and 1985, and to an average of plus 2 to 3 percent between 1985 and 1996. However, much will depend on the interest rate level, and the rate of inflation.

Assuming that the value of residential building permits issued by municipalities in Niagara is representative of actual residential construction, the estimated value of the permits issued during 1979 and 1980 may be used as the base for the projection. The actual investment will probably be subject to significant year to year variations. However, for purposes of estimating the cumulative requirement for mineral aggregate for residential construction, this approach is judged to provide reliable information (see Table 5.6).

Table 5.6

Residential Building Construction Expenditures Projection
and Related Mineral Aggregate Requirements,
Niagara Region, 1980 - 1996

	Projected Expenditures (in thousands of 1971 dollars)	Estimated Mineral Aggregate Requirement (4.363 tons per $1,000 worth of construction)
1980	$33,600.0	146,597 tons
1981	34,000.0	148,342
1982	34,408.0	150,122
1983	34,889.7	152,224
1984	35,447.9	154,659
1985	36,156.9	157,752
1986	36,916.2	161,065
1987	37,728.3	164,609
1988	38,596.1	168,395
1989	39,522.4	172,567
1990	40,510.5	176,747
1991	41,563.7	181,343
1992	42,686.0	186,239
1993	43,881.2	191,454
1994	45,153.7	197,006
1995	46,508.3	202,916
1996	47,903.6	209,003
Cumulative 1981 - 1996 Requirement		2,774,443 tons

C. Non-Residential Building Construction

The ups and downs in value of building construction permits issued in Niagara for non-residential construction between 1971 and 1979, on average, parallels the values recorded for the Province as a whole, i.e. investment in this category of construction declined over the decade. However, since the low point in 1977/78, consistent recovery has taken place both in the Province as a whole, and in the Region. Further growth may be expected in Niagara during the forecast period, particularly because of increased activity in the tourism, office, and health care sectors. Construction activity in the agricultural sector may also show continued growth.

Investment in non-residential construction in Niagara is expected to parallel closely the growth rate of the Ontario economy between 1981 and 1996. The Ministry of Treasury and Economics expects that this growth rate will be in the area of 1 percent (in real terms) during 1981 and will reach 2.2 percent by 1986. By 1996, an average annual growth rate of 3.2 percent per year is expected to be achieved.

The basis for projection used is the actual value (in 1971 dollars) or permits issued in 1979 ($36.9 million). As noted above, the actual investment will probably be subject to significant year to year variations. For purposes of estimating cumulative requirements for mineral aggregate for non-residential construction, this approach is judged to provide reliable information (see Table 5.7).

Table 5.7

Non-Residential Building Construction Expenditures Projection and Related Mineral Aggregate Requirements, Niagara Region, 1980 - 1996

	Projected Expenditures (in thousands of 1971 dollars)	Estimated Mineral Aggregate Requirement (7.872 tons per $1,000 worth of construction)
1980	$37,236.3	293,124 tons
1981	37,683.1	296,641
1982	38,210.7	300,794
1983	38,822.0	305,607
1984	39,520.8	311,108
1985	40,311.3	317,330
1986	41,198.1	324,311
1987	42,145.7	331,771
1988	43,147.2	339,733
1989	44,236.1	348,226
1990	45,386.2	357,280
1991	46,611.6	366,927
1992	47,916.8	377,201
1993	49,306.4	388,140
1994	50,785.5	399,784
1995	52,359.9	412,177
1996	54,035.4	425,367
Cumulative 1981 - 1996 Requirement		5,602,397 tons

D. Non-Road Engineering

The 1980-84 capital works budget of the Regional Municipality indicates that expenditures on water and sewer systems during the period will be generally below expenditures in recent years. If projected expenditures by the Regional Municipality on water and sewer installations would receive a subsidy of 15 percent from other levels of government, as indicated in the 1980-84 works budget, the total amount available for investment in these items in Niagara would amount to approximately $18.5 million (1971 dollars) over five years, or $3.7 million per year. The average expenditure each year on water and sewer works has represented approximately 20 percent of all expenditures on non-road engineering in the Region during the 1970s. If this relationship is assumed to remain valid during the 1980-84 period, the average annual expenditure on non-road engineering between 1980 and 1984 will be in the area of $18.5 million, or $92.5 million for the period. Based on the allocation of these expenditures as contained in the five year capital works budget, the annual expenditures on non-road engineering may be expected to be as follows:

1980	$19.9 million
1981	$20.6 million
1982	$16.6 million
1983	$17.6 million
1984	$17.8 million

These estimates take account of the effects of the recent cancellation of the federal program providing for financial participation in servicing projects.

As noted, water and sewer works have represented approximately 20 percent of the non-road engineering construction expenditure within the Region in recent years. In the course of assessing how much other non-road engineering construction work may be expected to take place within the Region, interviews were conducted with a number of organizations that may initiate works in this category during the forecast period. It was learned that construction related to electric power requirements will be limited to maintenance of existing generating facilities in place in the Region with some expansion in the delivery system as may be required to service additional demand. This represents a continuation of construction expenditure trends established during the 1970s.

The St. Lawrence Seaway Authority does not foresee any new construction of locks and other Welland Canal facilities, at least until 1990-91. If the traffic management system currently being put into place meets its objectives, no major works (other than regular maintenance) are expected to be considered until the end of the century. If it falls short of meeting its objective, consideration may be given to the expansion of the capacity of some of the locks. Design of the works involved could get underway during the first half of the 1990s, but actual construction is not likely during the forecast period.

Expenditures on dams and irrigation works, works related to gas and oil exploration, and railway construction are not expected to be significant in the Region during the forecast period. The likelihood of other forms of engineering construction (by private companies) was not researched. It is assumed that the value of their works will continue to approximately the expenditure levels on water and sewer construction.

Table 5.8

Non-Road Engineering Construction Expenditures Projection and Related Mineral Aggregate Requirements, Niagara Region, 1980 - 1996

	Projected Expenditures (in thousands of 1971 dollars)	Estimated Mineral Aggregate Requirement (15.479 tons per $1,000 worth of construction)
1980	$19,871.6	307,593 tons
1981	20,611.4	319,043
1982	16,644.4	257,639
1983	17,569.1	275,101
1984	17,772.6	274,375
1985	18,128.0	280,603
1986	18,256.8	286,777
1987	18,952.9	293,373
1988	19,407.8	300,414
1989	19,893.0	307,924
1990	20,410.2	315,930
1991	20,961.3	324,460
1992	21,548.2	333,545
1993	22,173.1	343,218
1994	22,838.3	353,514
1995	23,546.3	364,473
1996	24,299.8	376,136
Cumulative 1981 - 1996 Requirement		5,006,525 tons

Based on these considerations, it is assumed that, for projection purposes, expenditures on water and sewer construction will continue to represent an average of 20 percent of the total expenditures on non-road engineering construction in the Region between 1980 and 1996. Review of the probable activity in this field indicates that the growth rate in expenditures in Niagara is likely to be low, if any. For projection purposes, it has been assumed that this rate will approximate the growth rates in residential and non-residential construction (see Table 5.8).

In conclusion, the analysis presented above results in the projection of a total cumulative requirement (demand) for mineral aggregate within the Niagara Region of between 52.8 and 54.8 million tons between 1981 and 1996. This is projected as the amount required for construction purposes. Additional mineral aggregate is also required for various non-construction purposes (fill, landscaping, a variety of industrial and private uses, various recreation applications, etc.).

Non-construction uses of mineral aggregate generally are considered to represent about 10 percent of total demand. Research for this study did not point toward a high use in Niagara. Therefore, using the 10 percent estimate for non-construction purposes, the total cumulative demand in Niagara between 1981 and 1996 will range from 58.7 to 60.9 million tons. This is equivalent to an average annual requirement of between 3.7 and 3.8 million tons of mineral aggregate. The question is - how much of this demand will be for sand and gravel (the product of pits) and how much for crushed stone (from quarries)? The answer to this question is related primarily to the cost of the materials. Sand and gravel, and crushed stone can be substituted for one another in many construction applications. As sand and gravel can generally be produced for a somewhat lower price per ton, preference is usually given to the use of this material if other conditions (availability and transportation costs) would be equal.

Where availability of sand and gravel is restricted or is located at greater distances than quarry operations, crushed stone may be substituted. For example, the Ministry of Transportation and Communications indicated that it required no crushed stone in its road construction and maintenance projects in several parts of Central Ontario during 1978, 1979 and 1980. Instead, the Ministry used aggregate from pits. In the Niagara Region, on the other hand, 90 percent of the mineral aggregate requirements for road construction and maintenance were expected to be met by stone quarries, and only 10 percent by pits. This does not mean that the nature of the road work in Niagara is different as compared to other areas. It means that, in Niagara, the use of crushed stone costs less than the use of sand and gravel.

Between 1975 and 1980 about 23 percent of the mineral aggregate produced from pits and quarries and subsequently used in Niagara was represented by sand and gravel. As effective reserves of crushed stone within licensed quarries appear to be both abundant and accessible in Niagara, this material may be expected to continue to dominate mineral aggregate production in Niagara. If it is assumed that sand and gravel from pits maintains its share of the market (23 percent) then the average annual requirement is between 844,000 and 875,000 tons. The total cumulative demand for sand and gravel between 1981 and 1996 ranges from 13.5 to 14.0 million tons. In the last two years, 1979 and 1980, the market share for products from pits has dropped to just below 21 percent however. The future requirements for sand and gravel will be considered further in the concluding chapter.

5.3 Recent Ministry of Natural Resources Projections

In recent months, the Ministry of Natural Resources has prepared two projections of demand for aggregate within the Niagara Region for the 1980 to 2000 period. The first of these projections takes the results of the Ministry's estimates of demand within Niagara between 1976 and 1980, and projects this in a straight line by using a constant increase in demand. The second projection used the same basis and projects growth in demand at an average annual growth rate of 2 percent. The actual projections are graphed on Figure 7.1.

In reviewing the above projections, there are benefits from the information gathered for this study that were unavailable when the Ministry made its projections. Basically, the projections overestimate demand in Niagara by underestimating the amount exported. For example, in 1979, 1.5 million tons of aggregate were exported from Niagara. Thus, the demand in Niagara was 4.3 million tons rather than 4.9 million tons as indicated by the Ministry.*

Perhaps one reason why the Ministry overestimated demand in Niagara is the unavailability of a review of economic conditions which this present study has endeavoured to provide. This position on the part of the Ministry is understandable as they are looking at demand projections prepared for a much larger area than just Niagara.

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* The Ministry used a 1979 production level of 5.8 million tons from which exports are subtracted to obtain the amount used in Niagara. One could argue correctly that imports should also be considered. In 1979, imports were 168,000 tons of which 139,000 tons were specialized foundry sands.

Chapter 6

GENERALIZED ENVIRONMENTAL ASSESSMENT

6.1 Introduction

The development of sand and gravel resources from conventional land based pits results in primary and secondary land use and environmental impacts which require careful consideration and evaluation. This chapter documents some of these possible primary and secondary impacts and their on-site and off-site implications. Specifically, the generalized environmental assessment seeks to develop an environmental framework which could integrate these concerns and thereby contribute to the evaluation of possible aggregate resources sites.

To test the environmental framework and to provide some idea of the data base which would be necessary to make it fully operational the framework was applied to the Fonthill Kame and its immediate vicinity. The three graphic displays resulting from this application will be presented.

To assist in the development of the generalized environmental assessment and most particularly the environmental framework, Ecoplans Ltd. of Waterloo was retained.

Section 6.2 of this chapter will discuss the nature of environmental impacts, their primary and secondary character, and the need for an environmental framework to integrate and properly evaluate these impacts. The third section will explore the development of the environmental framework, the steps involved in its organization and the requirements for information it establishes. Section 6.4 identifies the selected study area which was used for application of the environmental framework and the reasons for selection of that study area. Section 6.5 illustrates the application of the environmental framework to the study area and specifically reports on the development of three graphic displays, Figures 6-1, 6-2 and 6-3, showing abiotic (physical), biotic (natural), and cultural/historical (man-made) features. The chapter concludes with a discussion of the possible impacts of sand and gravel operations.

The environmental framework presented below may be considered as an initial effort on which further refinements may be desirable. In particular, the informational requirements may be particularly difficult to satisfy completely. Nevertheless, they do point to the range of issues meriting consideration.

6.2 The Nature of Environmental Impacts

An understanding of the nature of environmental impacts and their character is a prerequisite in the development of an environmental framework. An environmental impact is any alteration of environmental conditions or creation of a new set of environmental conditions, adverse or beneficial, caused or induced by the action or set of actions under consideration. The choice of conditions to be considered in performing an environmental impact analysis generally varies according to the type of project, development or action under evaluation. The attention given to specific environmental conditions will also vary with the nature, scale and location of the proposed action(s).

The Niagara Sand and Gravel study has a specific focus on aggregate extraction. The environmental impacts are thus those associated with the conventional open pit sand and gravel mining techniques which are common in Southern Ontario and which are familiar in Niagara Region. While pit management techniques may vary between operators and locations the basic open pit excavation techniques are similar throughout the Region. To this extent the anticipated environmental impacts can be generalized into broad categories and then at a subsequent step into more detailed subcategories from a "checklist" of questions such as - "will aggregate extraction increase the erosion or runoff potential of the site?". This checklist is explained further in Section 6.3. Initially, however, it is useful to discuss aggregate operation impacts as either primary or secondary in nature.

Generally, environmental impacts can be categorized as either primary or secondary. It is important to keep this distinction in mind when considering alternatives and the way to minimize adverse impacts. Frequently, the distinction between primary and secondary impacts is based on the following: project "inputs" cause primary impacts and project "outputs" cause secondary impacts. In environmental assessments it is frequently easier to analyse and measure primary impacts, whereas secondary impacts are frequently more difficult to identify and analyse. However, the secondary impacts may be more significant than the primary.

Primary impacts are those impacts that can be attributed directly to the proposed development such as construction activities, operation of the facility and land use changes at the development site.

Secondary impacts are indirect changes and typically include the changed patterns of social and economic activities stimulated by the proposed action. Secondary impacts, related to an aggregate extraction undertaking might include land use changes, changes in land values surrounding the site, the formation of a citizen group or any number of biophysical responses. These secondary impacts may often be more substantial than the primary effects of the development.

In addition to the primary and secondary impacts the environmental framework should also consider the related issue of on-site and off-site impacts. This concept is linked to the primary/secondary categorization but is more specifically a reference to the spatial differentiation of environmental impacts. An aggregate extraction proposal may have very obvious on-site impacts such as the clearing of a woodlot or the removal of an orchard. Off-site impacts are less localized and take the form, for example, of changes in traffic patterns which affect a wider community than those people immediately adjoining a proposed pit.

Environmental impacts should also be considered in relationship to the stage or phase of the project. Projects typically evolve through a number of phases, most with some degree of environmental impact. The following table lists project phases and activities which may lead to environmental impact.

Table 6.1

Project Phases - Environmental Impact

Project Phase	Activities which lead to Environmental Impacts
Conception	- Not applicable
Planning	- Investigation
Development	- Construction
Operation	- Operation and Maintenance
Abandonment	- Dismantling, Disposal, Removal of Safeguards, Rehabilitation
Spinoff Projects	- Future and Related Activities

Source: Environment Canada. Ecological Land Survey Guidelines In Environmental Impact Analysis - Ecological Land Classification Series No. 13, 1981.

Different project phases give rise to different types and levels of environmental impact and this also needs to be considered in the development of the environmental framework.

The environmental framework should also address itself to the possibility of mitigation of possible environmental impacts. These considerations must be integrated into the overall decision-making process. The environmental framework has been developed with these type of considerations in mind: primary/secondary impacts, on-site/off site impacts and different project phases.

6.3 The Environmental Framework

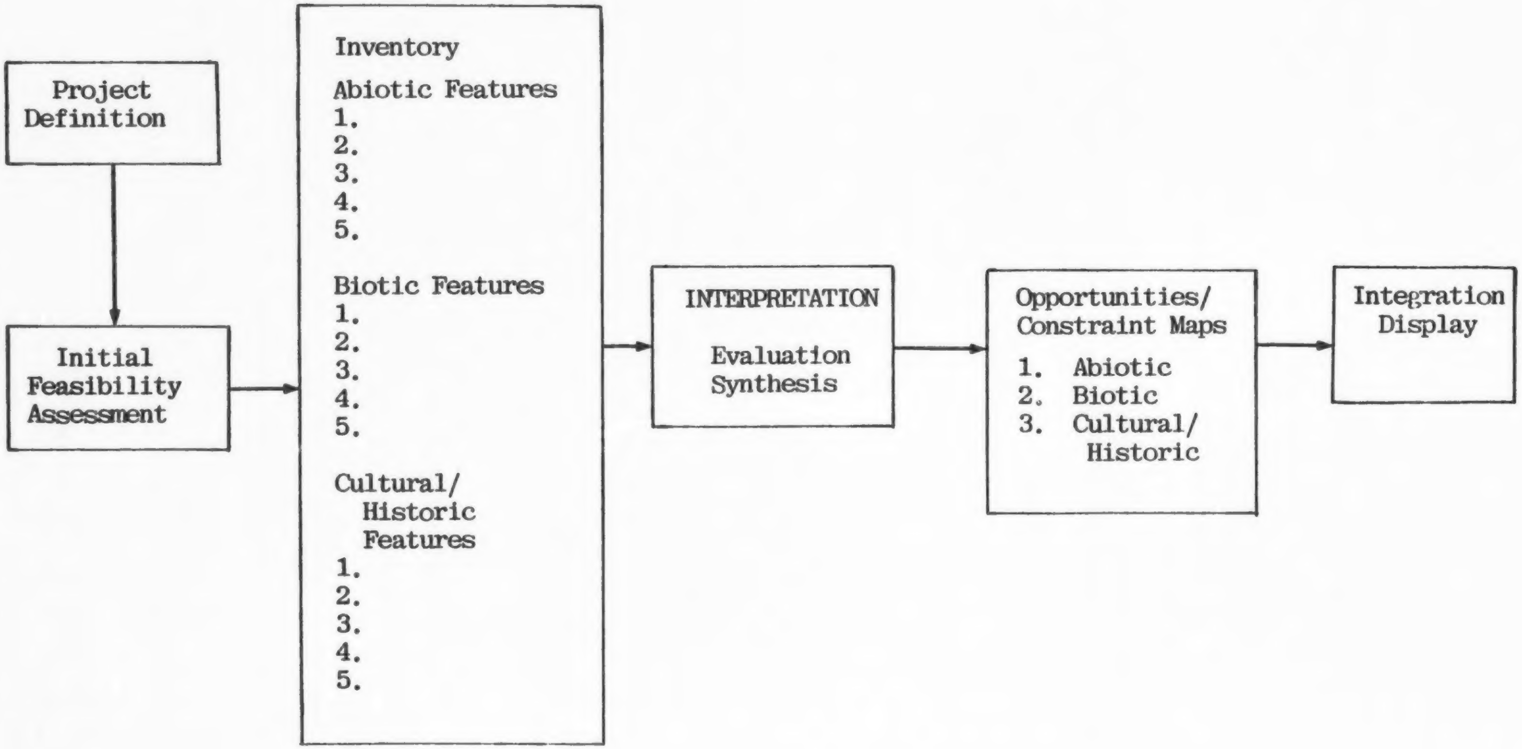
The environmental framework is a tool which has a specific listing of concerns and a specialized framework with particular information needs when considering sand and gravel extraction.

To introduce the steps taken in the development of the environmental framework a flow diagram showing the process is shown in Figure 6-4. This section will thus briefly outline the process and also discuss the information requirements the process establishes.

The steps established by the environmental framework move as shown in the flow diagram, from an initial project definition, in this case sand and gravel extraction operations, to an environmental assessment which presents an integration display which shows development concerns based on the environmental constraints identified by the framework. The process starts with a checklist of basic questions designed to reflect the major areas of potential environmental impact. The second step is to derive an environmental survey and compile the information necessary upon which to answer the questions which are developed in the first step. The third step is to evaluate the responses and identify the answers to the questions. The fourth step is to prepare three display maps. The three maps derive from the information gathered and its evaluation. The maps will show the major components of the abiotic (physical), the biotic (natural), and the cultural/historical (man-made) systems. These maps show the major components only and identify the features which are most relevant, from an environmental perspective, to the decision-making process. A fourth map, and the final step in the process, is a synthesis of the three other maps which seeks to identify the areas of major environmental constraints or, to look at it another way, the areas of least environmental impact.

Figure 6.4

Environmental Assessment Process


Project Definition
Initial Feasibility Assessment
Inventory
Abiotic Features
1.
2.
3.
4.
5.
Biotic Features
1.
2.
3.
4.
5.
Cultural/ Historic Features
1.
2.
3.
4.
5.
INTERPRETATION
Evaluation
Synthesis
Opportunities/ Constraint Maps
1. Abiotic
2. Biotic
3. Cultural/ Historic
Integration Display

The steps in the development of the environmental framework can also be explained by following through from one initial question from the checklist in Step 1. If the issue of soil quality impacts is taken as an example the steps would look as follows:

Preliminary Identification of the development project and the types of impacts.

Step 1 Formulation of the question.

Will the action significantly affect soil quality?

Step 2. Identification of the information requirements to answer the question identified in Step 1.

Basic Data	Interpretative Data
- depth	- soil capability for range of crops
- organic content	
- stoniness, texture	- erosion risk
- water regime etc.	- management problems
	- drainage, etc.

Step 3. Evaluation of the data provided in Step 2 and provision of an answer.
Yes. By destruction of the original soil profile. The topsoil is altered during excavation even if removed and stockpiled. In the past, extraction of sands and gravels have created relatively hostile sites for biological materials because of

a) absence of soil profile or a highly disturbed profile
b) unstable erosion surfaces
c) infertile mineral environment
d) areas of excessive drainage and exposure
e) difficulty in plant colonization

Step 4 Development of the display maps showing:

- steep slopes
- drainage patterns and water regime
- agricultural land use pattern

Step 5 Development of integration display map showing environmental constraints based on information mapped in the Biotic, Abiotic and Cultural/Historical maps.

To give a sense of the scope which is possible with the environmental framework a complete listing of the "questionnaire checklist" derived for application to the issue of sand and gravel extraction is provided.

ABIOTIC

1. Physical Land Base - Geology, Soils

   a) Is the designated resource area suitable for exploitation - quantity, quality, accessibility?

   b) Are there alternative resources areas for the resource - local, regional, outside of region?

   c) What effect will the action have on the geological formation (unique, integrity, extent)?

   d) Will the action significantly affect soil quality?

   e) Will the action increase (or decrease) the stability or instability of the soils and/or geology of the site?

   f) Are the geologic or soil conditions of the site hazardous to building construction and human occupancy (predevelopment, post-development)?

   g) Will the action increase the erosion or runoff potential of the site?

   h) Is the site subject to unusual terrain features such as steep slopes or other conditions affecting construction, drainage or livability?

   i) Are there or will there be unusual risks from natural hazards such as unstable slopes or the presence of water bodies or other hazardous terrain features?

   j) Will the undertaking induce microclimatic changes on the site or in the vicinity of the development?

2. Pollution Effects

   a) Air Quality
      i) Will the action result in emissions into the atmosphere of significant amounts of pollutants - dust and other process byproducts (limestone kilns, cement plants, asphalt plants)?

      ii) How and to what extent will the action affect air quality?

      iii) Will it contribute to a degradation of air quality?

      iv) Will it cause a change in chemical and physical composition?

b) Water Quality

- i) How and to what extent will the action affect the availability, supply, use and quality of water, both surface and subsurface?
- ii) Will the action cause pollution or affect commercial or sports fisheries?
- iii) Will it affect waterway regulation and stream regulation activities?
- iv) Will the action interrupt surface drainage patterns - diversion of stream, interbasin transfer?
- v) Will the action introduce substances or solid wastes into bodies of water (asphalt residue, petroleum).
- vi) Will the undertaking contribute to a significant depletion or degradation of ground water?
- vii) Will the action significantly increase sedimentaion in a stream or body of water?
- viii) Will the action significantly alter the temperature of a body of water?
- ix) Will the action create "new" bodies of water?

c) Noise Quality

- i) Will the action result in the generation of excessive noise in terms of proximity of humans and wildlife?
- ii) Will the undertaking result in the kind of noises and noise levels that will be distrubing or a nuisance in the immediate and general areas?

d) Hazardous Substances

- i) Will the proposed development create or generate any substances, materials or activities that are dangerous (toxicity, flammability, explosive characteristics)?
- ii) Will it create or generate substances that might result in contamination or deterioration of food, food sources, clothing or other materials?

BIOTIC RESOURCES

1. Vegetation and Wildlife Resources - Biotic Aspects

a) Will the development result in significant destruction of vegetation, wildlife or aquatic life?

b) Will the action substantially alter the breeding, nesting or feeding habitats for birds?

c) Will the action significantly alter the patterns or behavior of fish and animals?

d) Will the development significantly affect, beneficially or adversely, other forms of life or ecosystems of which they are part?

e) Will the action cause changes in biological productivity including wildlife habitat and population losses?

f) Will the action affect rare or endangered species, or cause changes in species diversity?

g) Will the action create opportunities for additional vegetation or wildlife species?

h) Will the effects of the action be long term, moderate term or short term in their affect?

i) Will the project affect renewable resources development, production, management, harvest, transport and use, such as forestry production, agriculture and wildlife?

j) Will the action affect natural resources and energy conservation?

CULTURAL HISTORIC

1. Land Use and Land Management Effects

a) Recreation
   i) Will the action have a significant effect on public parks or other areas of recognized or potential scenic or recreational value?

b) Historic, Architectural and Archaeological Preservation
   i) Will the development have a significant impact on areas or sites of recognized or potential archaeological value or buildings or sites of historical value (local, provincial, federal)?

c) Aesthetics - Landscape Quality
   i) Will the undertaking affect areas of unique interest or areas of outstanding natural beauty?

   ii) Will the action affect the aesthetic qualities of the site, surrounding area, and region?

   iii) Will the action affect the aesthetic quality of the area in the short term (0-5 years) medium term (6-15 years) or long term (more than 15 years)?

iv) Will the action create an unattractive contrast between existing vegetation and landscaped areas; between natural land forms and excavation site; and between existing development patterns and pit quarry features.

d) Settlement Infrastructure

i) Will the undertaking cause a significant impact on existing infrastructure involving transportation, energy movement and communication facilities (roads, railways, pipelines and transmission lines, radio and television transmitters, cables)?

e) Settlement Planning

i) Will the undertaking affect urban and regional planning within the area (Official Plans)?

ii) Will the undertaking affect agricultural and resources management within the study area and outside the study areas?

2. Socioeconomic Effects

a) Will the development divide or disrupt existing land use?

b) Will the development increase traffic flow and congestion?

c) Will the action affect the "quality of life" of the residents of the area?

d) Will the development affect neighbourhood character and cohesion?

MITIGATION EFFECTS

a) Can the adverse impacts of the undertaking be avoided altogether by not taking certain actions or parts of actions?

b) Can the adverse impacts be limited by limiting the degree or magnitude of the action and its implementation?

c) Can the adverse impacts be rectified by repairing, rehabilitation or restoring the affected environment?

d) Can the adverse impacts be reduced or eliminated over time by preservation and maintenance operations during the life of the undertaking

e) Can the adverse impacts be compensated for by replacing or providing substitute resources or environments?

The questionnaire checklist leads to a wide range of information requirements which may not be completely possible to obtain. The full list of information which would be ideally sought to answer the many questions posed in Step 1 is provided as follows:

ABIOTIC RESOURCES

	Basic Data and Derived Attributes	Interpretative
1. Landforms	- physiography - local relief - slope - thickness of surface materials - surface expression (local forms) - genetic origin of surface material - texture of surface materials	- potential for aggregate material - hazard lands
2. Soils	- depths - organic content - pedogensis, association - stoniness, texture - pH, fertility - water regime in soils	- Agriculture-soil capability according to limiting factors - soil capability for range of crops (speciality) - management problems - irrigation, drainage, flood hazard - capability for range of uses urbanizations, etc. - trafficability - surface materials or slope conditions
3. Rivers and Streams	- channel patterns - type - size of streams and rivers - erosional and depositional features - relative abundance-drainage network - water regime - seasonality - bank stability	- risk of bank erosion or desposition, bedscour, etc. - fish spawning or habitat areas - flood risk, magnitude and probability - tolerance to increased flows regulation and/or sediment - tolerance to thermal discharge - hazard lands

4.	Water Quality and Quantity	- present quality and quantity - sources of flow-regime	- tolerance to pollution introduction - tolerance to water level changes, flow changes
5.	Noise	- present noise level	- anticipated noise levels
6.	Air Quality	- present air quality	- risk evaluation

BIOTIC RESOURCES

1.	Vegetation	- general vegetation (hardwoods) - cover type, spatial distribution - fire and other disturbances - species - abundance, dominance - regeneration	- Forestry-productivity - potential for diverse species - rare and endangered species - survivability sensitivity under range of impacts - potential for natural regeneration - management requirements cutting, protection - replanting
2.	Fish and Wildlife	- habitats (potential, critical or specialized) - possible - actual species on site	- land capability for ungulates - land capability for water fowl - land capability for other species - land capability for plants used by wildlife - tolerance to disturbance by undertaking

CULTURAL HISTORIC

1.	Archaeological	- known sites - high probability area for sites	- risk of disturbance - potential for predevelopment excavation and salvage
2.	Historical	- known sites	- risk of disturbance - potential for predevelopment salvage
3.	Recreation	- local, provincial and federal sites - potential outdoor recreation areas - use patterns - intensive and extensive	- landscape potential to support activities - sportfish potential - hunting potential - use of streams and rivers - walking, skiing potential

4.	Aesthetics	- landforms - vegetation patterns - relief - aquatic features	- landscape attractiveness - surrounding vistas, panoramas, etc. - exceptional features - tolerance for disruption
5.	Land Use	- Agriculture - farm pattern	- tolerance to disruption
		- Residential - pattern	- tolerance to disruption
		- Infrastructure - pattern	transportation, utilities, pipelines, power corridors
		- Resource Use - pattern gravel - forestry	- tolerance for disruption - environmental sensitivities
6.	Planning Framework	- Existing Plan and Programs for Area	- conformity and potential for disruption

Many conditions will affect the type of information that must be developed in any given environmental framework. Thus, in individual environmental assessments some of the questions and the information requirements may be redundant. In addition, an attempt to fully answer all of the questions and develop a full set of information from the list of information requirements may be either impossible or inappropriate given the objectives of the assessment. Thus before application of the environmental framework and the conclusion of the environmental assessment several factors need to be considered including:

- the area to be covered by the assessment,
- the level of generalization,
- the amount of information for each mapped area, and
- the reliability of the information and the mapping

These factors will be primarily influenced by the objectives of the environmental assessment. If the assessment seeks to evaluate a site specific development such as a particular application to develop a new sand and gravel pit it may be possible, desirable and necessary to develop a more comprehensive environmental assessment based on a highly detailed environmental survey and research program. If, on the other hand, the objectives are more general in nature, less site specific and designed to draw attention to potential environmental impacts rather than specific site-related impacts, the information requirements will be less. In the latter case the assessment could be described as a "generalized" environmental assessment appropriate to broad scale evaluation of site alternatives.

6.4 Generalized Environmental Assessment: Study Area and Application

Following the development of the environmental framework and given the overall objectives of the Niagara Sand and Gravel Study, the framework was applied to the Fonthill Kame and vicinity. The choice of the generalized approach was based on the need not to respond to a specific sand and gravel development but to provide a broad picture of the impacts of sand and gravel operations and attempt to consider the level of environmental impacts associated with different resource locations. The generalized environmental assessment thus does not seek to be a definitive statement of environmental impacts but rather seeks to "flag" areas of concern.

Application of the framework to the Region as a whole and to all of possible sand and gravel resource areas was beyond the scope of the study. Such an assessment would have involved considerably more information, time, and resources than were available. A decision therefore was made to apply the framework to the area of most significant sand and gravel development in the Region. The Fonthill focus was further reinforced by the existance of three either current or anticipated sand and gravel development applications.

In the application of the environmental framework the first task was to identify study area boundaries. This was done with special regard to the Kame feature itself which is identified in the Ministry of Natural Resources Aggregate Resources Inventory of the Town of Pelham (1980). The second major determining factor was to set the boundaries so that a proper evaluation of the possible off-site environmental impacts could be conducted. The boundaries should include an area sufficiently beyond the Kame to allow concerns related to natural watercourses, urban development, agricultural land use patterns and other issues to receive proper consideration. Setting the boundaries too close to the Kame could result in missing possible environmental impacts. A decision was therefore made to err on the side of a somewhat larger study area than that suggested by a focus exclusively on the Kame.

The generalized environmental assessment study area boundary thus follows the Ontario Hydro right-of-way which traverses the Short Hills Park Reserve to the north, Catacact Road to the east, the City of Welland and Town of Pelham municipal boundary to the south east, Sumbler Road to the south and Regional Road 24, the boundary between the Town of Pelham and the Township of West Lincoln to the west. The study area thus incorporates the urban area of Fonthill and the designated hamlets of Fenwick and North Pelham, the southern extremities of the Short Hills and the headwaters of Twelve Mile Creek and two other zones draining into Fifteen Mile Creek and south to the Welland River respectively.

The precise boundaries are shown on the three graphic displays which are discussed in the following section.

6.5 Application of the Environmental Framework: The Generalized Environmental Assessment

As described in section 6.2 and 6.3 the environmental framework establishes a process for evaluating the possible impacts of sand and gravel pits on the Fonthill Kame and vicinity. The process leads from the development of a questionnaire checklist, to the development of an information inventory and thence to the preparation of three graphic displays indicating Abiotic, Biotic and Cultural/Historical features. A fourth, integration display showing areas of sand and gravel constraints and derived from the three display graphics will be presented as part of the concluding chapter of the Study.

The three graphic displays are shown as Figures 6.1, 6.2 and 6.3 in the attached pocket at the end of the Study. The information used in the preparation of the 3 maps was derived from existing published and unpublished sources and aerial photography. Field checking of the information was conducted by the use of windshield surveys of the study area. More detailed data collection by the use of on site field work and evaluation was not possible. The data available have thus, for example, only been able to identify wooded and reforested areas, and do not represent a detailed inventory of the flora and fauna associated with those areas. Weighting the relative values of the wooded areas has thus not been possible nor attempted. In other areas data limitations have imposed similar limitations on data interpretation. In the area of fish habitat for example, the generalized environmental assessment has been unable to identify the degree of possible impacts on the cold water trout in the upper tributaries of Twelve Mile Creek. The assessment is able to suggest that in certain cases there could be a negative impact on such fresh water fish but is unable to say conclusively that this is a danger in the case of Twelve Mile Creek.

The data limitations and the constraints these will place on interpretation and policy development are not unexpected. Emphasis should be put on the large study area under review and the generalized rather than site specific nature of the assessment. The generalized environmental assessment and specifically the three graphic displays which will be discussed subsequently are however of considerable value in identifying wider area level environmental constraints. These overriding general constraints will be discussed in the context of the final integration display in the Study's

conclusion

a) Abiotic Features

The first graphic display, Figure 6.1, shows abiotic features. These are the physical, land based features related to surface topography, geology, surface and subsurface drainage, and soils. Because of the generalized nature of the environmental assessment, the size of the study area, and the mapping scale the display concentrates on topography and drainage. Soils information will not be presented but data on the existing agricultural land use pattern which is partially based on soils capability is presented on the Biotic Features map, Figure 6.2.

The Abiotic Features map highlights the surface drainage pattern. The 1:24,000 base map prepared for the study area already shows the streams and creeks and these have been emphasized in the display. The drainage pattern clearly indicates the height of land represented by the Fonthill Kame by showing drainage from the Kame in three directions - north east as part of the Twelve Mile Creek System, south as part of the Welland River system and north west into the Fifteen Mile Creek basin. The watershed units are also shown on the map by the drainage divides.

The display also shows the water regime. This information was derived from data prepared by Terra Scan Limited for the Niagara Escarpment Task Force in 1973. The water regime data indicate that groundwater tends to mound under the Kame and flow outwards in all directions. This water emerges further downslope at elevation 650'± to 690'± as a sping line. Surface drainage flows outward in all directions from the Kame recharge area at the top and centre of the feature.

The topography of the Fonthill Kame has been emphasized by mapping of hazard lands. These refer to areas of slope over 10% and clearly show the steep north facing slopes of the Kame and the southern end of the Short Hills. The area south of Highway 20 falls more gradually with slopes between 5% and 10%. These more gradual slopes have not been shown on the display.

b) Biotic Features

The Biotic Features map, Figure 6.2, concentrates on natural woodlots and reforested areas and on the agricultural land use pattern. The mapping of the woodlots and reforested areas was drived from aerial photography (1975) combined with windshield surveys of the study area and data gathered by a joint federal and provincial agricultural land use systems mapping study of the Town of Pelham done in 1980. This study also contributed information to the mapping of the agricultural land use pattern.

Those wooded areas surveyed by the Niagara Environmentally Sensitive Areas Study (September, 1980) are also mapped. The major area depicted is identified in the Niagara ESA Study as Site PL-01 Short Hills/St. John and encompasses the primary headwaters watershed area for the Twelve Mile Creek. The area in the ESA designation is large enough (257 hectares) to support an extensive population of deer and avian species and a number of rare vegetation species. The area met 8 of the 9 ESA designation criteria which were used by the Niagara ESA Study. Four other areas which were inventoried by the Niagara ESA Study but which were identified as marginally sensitive are also shown. These are the Juard Woodlot (Site PL-03) south of Canboro Road north of Welland Road between Poth Street and the Fonthill urban area boundary, and the Rose Little Woodlot (Site PL-10)south east of Fonthill between the CN right-of-way and Rice Road. The third site is in the extreme south west corner of the study area and is identified in the ESA Study as the Sumbler Road Woodlot (Site PL-04). The fourth site is described as Boye's Woodlot (Site PL-02) and is south of Highway 20 close to the West Lincoln Township boundary.

As noted earlier information derived from the recently completed agricultural land use systems mapping was used to present data on the current agricultural pattern of the study area. For the land use systems mapping a detailed site inventory of the Pelham area was conducted which classified agricultural uses into four major systems - fruit and grapes, specialty crops, field crops and non-agricultural uses such as rural residential, transportation, aggregate extraction, idle agricultural and scrubland. Within each major classification there were numerous sub categories identifying particular crops or crop combinations. For the purposes of the Biotic Features map the information available was generalized to show the fruit and grape areas and the combined general field crops and specialty crops. The agricultural uses falling under each of these two mapped categories are as follows:

Fruit and Grape Systems
  - peaches
  - cherries
  - orchard (pears, plums, apples)
  - vineyards
  - combinations of the above

Field and Specialty Crops
  - row crops
  - corn-wheat
  - mixed (cereals, corn, hay, pasture)
  - hay-grain
  - grazing
  - vegetables and berries
  - nurseries
  - sod
  - greenhouses

c) Cultural/Historic Features

The cultural/historic features are shown on Figure 6.3 and represent a broad picture of man's influence on the landscape through development patterns and planning and development regulations.

The major underlying development pattern is that which is shown on the base map itself. The transportation network and the original land survey and development pattern are clearly visible as highways, concession roads, railways, and residential nodes. This pattern can also be seen by examination of the agricultural pattern presented in Figure 6.2. The urban development pattern of the study area is shown in four ways. First, the approved Urban Area Boundary for Fonthill is shown. Second the village residential designation for the hamlet of Fenwick is shown. Third, the extent of the urban pattern outside these designated areas has been plotted. In this latter case the development shown abutting Canboro Road, and surrounding the hamlets of North Pelham, Effingham and St. Johns were determined by field survey and from the agricultural land use systems mapping. And fourth, the development pattern is further identified by mapping clusters of low density rural residential development. Major community facilities in the form of schools, churches, and cemeteries are also identified.

The two other major man-made physical impacts on the study area are the licensed sand and gravel pits on the Kame and the Ontario Hydro rights-of-way which cross the northern half of the study area. The licensed pits are concentrated north of Highway 20 between Cream Street and Effingham Road. The "possible aggregate area" east of the licensed TCG pit which is designated in the Niagara Regional Policy Plan is also shown.

Both major public and private open space areas are shown on the display. The two major public facilities are the Short Hills Park Reserve to the north which is owned by the Provincial Ministry of Natural Resources and immediately north of the urban boundary of Fonthill the St. Johns Conservation Area owned and operated by the Niagara Peninsula Conservation Authority. Three privately owned open space areas are shown - Bissell's Hideaway north of Metler Road, Lookout Golf Course on the north face of the Kame between Tice and Metler Roads and the Steed and Evans golf course within the boundary of their licensed extraction area between Highway 20 and Tice Road.

Four areas of archaeological interest are shown. These areas were identified by the Provincial Ministry of Culture and Recreation's Historical Planning and Research Branch.

As an indication of the aesthetic attractiveness of much of the study area a tour route promoted in the Festival Country tour guide circulated by the Provincial Ministry of Industry and Tourism and the Niagara and Midwestern Travel Association is shown. This tour takes travellers south through the Short Hills along Effingham Road then along the north face of the Kame by Metler and Tice Roads via North Pelham and back through Fonthill and north again into the Short Hills towards St. Johns. Points of interest include the Comfort Maple at North Pelham, the Rice-Moore House on Tice Road and the lookout at the intersection of Tice Road and Lookout Street by the Golf Course where "from this point, the highest elevation on the Escarpment, you can see Lake Ontario to the north and Niagara Falls to the east on a clear day."

Planning regulations are represented as noted earlier by the urban area boundary of Fonthill, the village residential designation of Fenwick and the licensed aggregate areas. In addition to these regulations, the area covered by the Proposed Plan for the Niagara Escarpment is shown.

6.6 Conclusion

The development of the three graphic displays is based on an evaluation of the types of impacts which can be associated with and should be addressed during the planning, excavation, operation, abandonment, and rehabilitation of a sand and gravel pit. Based on the questionnaire checklist and the information inventory, the most noteworthy possible impact areas are aesthetics, water quality and quantity, biotic resources, traffic patterns and socioeconomic impacts. A detailed listing of the types of impacts which are possible follows:

ABIOTIC

Abiotic affects of aggregate extraction could include:

1) the unavoidable creation of a new local landscape with slopes and surface configurations often very different from those of the surrounding area.

2) the creation of steep and frequently unstable slopes which are difficult to stabilize and rehabilitate.

3) the creation of new water bodies.

4) the destruction of the original soil profile. The topsoil is altered during excavation even if removed and stockpiled. In the past, extraction of sands and gravels have created relatively hostile sites for biological materials because of:

    i) absence of soil profile or a highly disturbed profile;
    ii) unstable erosion surfaces;
    iii) infertile mineral environment;
    iv) areas of excessive drainage and exposure; and
    v) difficulty in plant colonization

Possible water related impacts to be addressed include one or more of the following:

1. turbidity and silting of adjacent streams and reservoirs caused, for the most part, by the erosion of the raw soils exposed during construction and maintenance operations (the primary impact of these effects generally involve increased operating costs or shortened life of affected reservoirs and channels; damage or elimination of fish and other aquatic life and possible damage to buildings, roads and bridge (foundations);

2. watershed modifications caused by the impingement of the site and its development on marshes, wooded swamps, and streams;

3. runoff contamination caused by runoff containing oil, fuel, etc.

4. contamination of surface and ground water supplies and recharge areas by polluted fill material; where the use of polluted fill material can affect the concentrations of biological, physical, and chemical, contaminations in water supplies.

Air and noise quality impacts may include:

1) Dust and/or particulate matter on vegetation and structures surrounding the excavation site and haulage roads,

2) Disturbance of surrounding passive recreational activities requiring quiet conditions for their enjoyment,

3) Disturbance of surrounding residential development,

4) Disturbance of other activities (institutional sites, schools, commercial establishments, etc.) sensitive to noise.

BIOTIC

Wildlife impacts would generally include:

1) loss or degradation of unique or highly productive wildlife and/or fish habitats;

2) division of wildlife ranges and migratory patterns;

3) displacement of wildlife to other ranges;

4) impairing or blocking migration and/or movement of aquatic biota; and

5) visual disturbance of wildlife on adjoining lands.

Vegetation impacts might include:

1) loss of forest cover of varying quality;

2) loss of locally, regionally or provincialy significant, individual plants, species or forest stands,

3) fragmentation of extensive woodland areas.

CULTURAL HISTORIC

Cultural historic and land use impacts might include:

1) removal of residential, commercial, and industrial land uses and displacement of both residents and jobs;

2) removal of structures or sites of scenic, architectural, archaeological, or historic significance;

3) loss of sites having unique potential or suitability for commercial or industrial activities;

4) loss-gain of taxable private land revenues.

Traffic and circulation impacts could include:

1) Increasing truck and equipment traffic on public roads.

2) Increasing traffic travelling through the area.

3) Dividing single land uses or resource areas such as agricultural operations, recreation areas, wildlife ranges or habitats, thereby inhibiting movement.

Of general concern relative to aesthetics are impacts such as:

1) Unattractive contrast between existing vegetation and revegetated or landscaped areas, between natural landforms and excavated site and between existing development patterns and pit and quarry features.

2) Visual distraction in recreational and residential areas from points off-site and away from the land feature.

3) Scale of excavation in contrast with surrounding land uses.

4) Interruption of view lines, blocking of viewlines or remonval of vantage points.

These possible environmental impacts take on more significance in the preparation of the final integration display which will be presented in the concluding chapter of the Study.

Chapter 7

CONCLUSIONS AND POLICY ISSUES

This report has brought together significant information on the sand and gravel industry in Niagara. A general conclusion is that sand and gravel from pits is part of the overall supply of mineral aggregate rather than being a distinct component. On the demand side, future requirements are unlikely to reach past levels. The economy is changing and so too are government expenditures from "hard" to "soft" services.

In the following section, an overview of the main findings is presented. This then serves as a reference for examining several policy issues. The concluding section also reviews some unanswered questions regarding the supply of mineral aggregates.

7.1 Conclusions

The conclusions are presented under four headings: supply, alternatives, demand, and environmental assessment.

7.1.1 Supply

a) Production

In Niagara, the production of mineral aggregate has declined through the 1970s. Table 7.1 illustrates this decline by comparing production in 1973 with that for 1979. Overall, production declined by 1.5 million tons or 21 percent. The drop in sand and gravel production accounts for over 51 percent of this total amount. As a result, by 1979, quarries provided 82 percent of the total production compared with 16 percent for pits and 2 percent for dredging. By way of contrast, almost 30 percent of Ontario's total mineral aggregate production was from quarries, 70 percent from pits and less than 1 percent from dredging.

Table 7.1

Comparison of Aggregate Production
Niagara Region
1973, 1979
(in thousands of tons)

Year	Crushed Stone	% of Total for Year	Sand and Gravel	% of Total for Year	Dredging	% of Total for Year	Total
1973	5,196.9	71.6	1,710.4	23.6	350.8*	4.8	7,258.1
1979	4,706.1	81.9	933.5	16.2	109.5	1.9	5,749.1
Change							
Absolute	(-490.8)		(-776.9)		(-241.3)		(-1,509.0)
%	(- 9.4)		(-45.4)		(-68.8)		(-20.8)

* Particularly high level of production from dredging as no other year between 1972 and 1979 had production over 200,000 tons. See Table 4.5.

This trend of declining production has continued in 1980. Recently obtained figures for Niagara indicate that total production stood at 5.6 million tons with 4.6 million tons from quarries, 860,000 tons from pits, and an estimated 100,000 tons from dredging.

The Fonthill Kame is the major source of sand and gravel in Niagara. In 1979, the three licensed pits on the Kame provided 79 percent, 820,000 tons, of the sand and gravel production which includes material from dredging. In the early 1970s production was not centred as much on the Kame due to greater production from the St. Davids area and dredging.

b) Exports and Imports

In order to estimate the amount of mineral aggregate used, at least initially, in Niagara, exports and imports needed to be considered.

Little sand and gravel is shipped outside of the Region. Only 33,000 tons or about 3.5 percent of total pit production was exported and this was primarily to the Hamilton-Wentworth and Haldimand-Norfolk areas. Of the dredged sand and gravel, about 56,000 tons or 51 percent of the material was exported and this primarily to the Hamilton-Wentworth area.

Exports from quarries represent about 94% of Niagara's mineral aggregate exports. In 1979, 1.4 million tons were exported, primarily to the United States with small amounts being shipped to Hamilton-Wentworth and Haldimand-Norfolk.

Imports of both sand and gravel, and crushed stone are small, about 170,000 tons. The imported sand and gravel represent specialized products which are not available from local sources. Of the 143,000 tons of sand and gravel imported in 1979, about 139,000 tons were specialized foundry sands for use by General Motors in St. Catharines and the remaining tonnage was pea gravel trucked in from Brantford.

Of the 5,749,100 tons of aggregate produced in Niagara in 1979, 4,253,100 tons or 74 percent were used here. In addition, about 170,000 tons of mainly specialized sand and gravel products were imported into Niagara.

c) Future Sources of Supply in Niagara

For sand and gravel, there are between 12 and 14 million tons of reserves available in the existing nine licensed pits. About 4 to 6 million tons of this total are located on the Fonthill Kame from which a variety of products can be produced ranging from sand fill to Fine Aggregate including concrete and mortar sand. Around 8 million tons of mostly sand fill are thought to remain within licensed pits at St. Davids. The two pits along Lake Erie have a very small reserve of blending and foundry sands, somewhere around 130,000 tons in total.

In comparison, there is a large reserve of about 275 million tons of aggregate in the ten existing licensed quarries. These reserves are fairly well distributed across Niagara.

The exact amount of reserve available in the three areas licensed for dredging is not known. It is thought, however, that the reserve is fairly large.

Possible resource areas for sand and gravel outside of licensed pits may be classified into five types:

(i) relatively small, scattered deposits of limited depth. These deposits have limited commercial potential although containing a combined total of around 5 million tons of sand and gravel.

(ii) dunes both along the Lake Erie shoreline and inland in the Township of Wainfleet. Their potential would seem to be limited although further investigations may prove otherwise particularly for the Wainfleet dunes.

(iii) the Fonthill Kame which has been estimated to contain an additional 95 million tons of sand and gravel outside licensed pits. This does not include undetermined supplies of "secondary significance" beyond the Kame.

(iv) the St. Davids area which is thought to contain mostly lower grade products like sand fill but deserves a closer inspection.

(v) dredging which seems to offer some potential for expansion. One preliminary estimate places the amount of sand and gravel available in the Niagara River mouth deposit at over 120 million tons.

In addition, there are quarries which already contain large reserves within their licensed areas, and can and do produce products which compete with those from pits. Quarries are considered further in Section 7.1.2.

7.1.2 Alternatives

What are the alternatives to land-based sand and gravel pits in Niagara? Two alternatives already have been mentioned above, namely, quarries and dredging.

Products from quarries to a significant degree are interchangeable with products from pits. In a Ministry of Transportation and Communications study of aggregate consumption for road engineering throughout Central Ontario, it was found that 67 percent of the aggregate came from pits and 33 percent from quarries but for Niagara the ratio was 10 percent from pits and 90 percent from quarries. The findings of the survey of Niagara's municipal use of aggregate confirms the Ministry's study as about 86 percent of aggregate purchased came from quarries and only about 14 percent from pits. In terms of the use of Granular Aggregate, it was found that about 90 percent of the granular products came from quarries and only about 10 percent from pits.

In Niagara, Fine Aggregate was primarily produced from pits. Today, although pits are still the most significant source, manufactured sand produced in quarries is becoming more important. Two quarries currently produce about 125,000 tons of manufactured sand per year. Although it has been substituted for pit sand in concrete blocks and for ice control, it has not been as successful in replacing natural concrete sand. Ready-mix firms still purchase about 90 percent of their Fine Aggregate needs from land based pits, 8 percent from quarries and 2 percent from dredging.

Quarry products are already being used in Niagara as substitutes for a wide range of granular products produced in pits and to varying degrees in products requiring Fine Aggregate. While products from quarries cannot be considered a total substitute for pits, they can reduce the future demand for sand and gravel. Of particular significance with increasing energy costs is the position of the quarries relative to the market. Although quarry products may be more expensive to produce, the location of some quarries closer to particular markets may reduce the delivered price of their products below the delivered price from pits.

Dredging is a second alternative to consider. During the 1970s it has provided about 11 percent of Niagara's sand and gravel production. The production has been in the form of Fine Aggregate used primarily as winter, mortar, and concrete sand. The present use of the dredged material would indicate that it is at least suitable for these uses. Whether the material available from dredging can be a total substitute for sand from pits remains unclear. Nonetheless, it cannot be ruled out as an alternative and, as an alternative source, is deserving of further study.

The substitution of industrial waste products such as slag for mineral aggregate is primarily for use as granular and fill products. Thus, while in the future these products may be used more extensively in Niagara, the impact on sand and gravel usage for Fine Aggregate is likely to be minimal.

Looking beyond Niagara for sources of sand and gravel, transportation costs enter the picture since aggregates are a bulky, relatively low value product. Transportation costs may account for 50 to 70 percent of the products' cost. Bringing sand and gravel to Niagara by truck or rail would increase costs. For example, the estimated cost of a 60 mile haul from Brantford would be in the order of $2.70 a ton by rail and between $4.20 and $5.60 a ton by truck. This illustration is based on estimates of rates which would be subject to negotiation. Thus, a ton of Granular A available at pits in Niagara for around $2.65 to $2.95 a ton would have about a minimum cost of $7.25 a ton if trucked in from Brantford.* This represents a cost increase of 171 percent. Shipments by rail would be less with comparable figures being $5.65 a ton for Granular A or an increase of 113 percent. The above figures illustrate the direction and amount of the cost increase. They would be influenced by such factors as availability of supply from other areas, rising energy costs, and the need to establish distribution yards if the material was brought in by rail. Such factors would tend to increase the costs. The alternative for granular material is local quarries which sell Granular A for $3.25 to $3.60 a ton.

Industrial waste products such as slag and fly ash may be used as granular material or fill, two products for which there is a fairly abundant local supply from pits and quarries. The recycling of pavements and the use of building products such as steel and brick may reduce the demand for aggregates somewhat.

7.1.3 Demand

Between 1981 and 1996, the total cumulative demand for mineral aggregate in the Niagara Region will range between 58.7 to 60.9 million tons. This is an equivalent to an average annual requirement of between 3.7 and 3.8 million tons. This projection allows for increased economic activity through residential, commercial and industrial building construction. Expenditures on roads are projected to remain stable or decline somewhat as they have through the 1970s. This difference in the consideration of road expenditures at either a stable or declining rate accounts for the two projections.

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* Based on Granular A costing $2.95 a ton at the gate in Brantford.

Demand is distributed among the four construction categories as follows:

		Cumulative 1981-1996 Requirements
(i)	road engineering -	39.4 to 41.4 million tons
(ii)	residential building -	2.8 million tons
(iii)	non-residential - building	5.6 million tons
(iv)	non-road engineering -	5.0 million tons

Another 5.9 to 6.1 million tons is required for non-construction purposes.

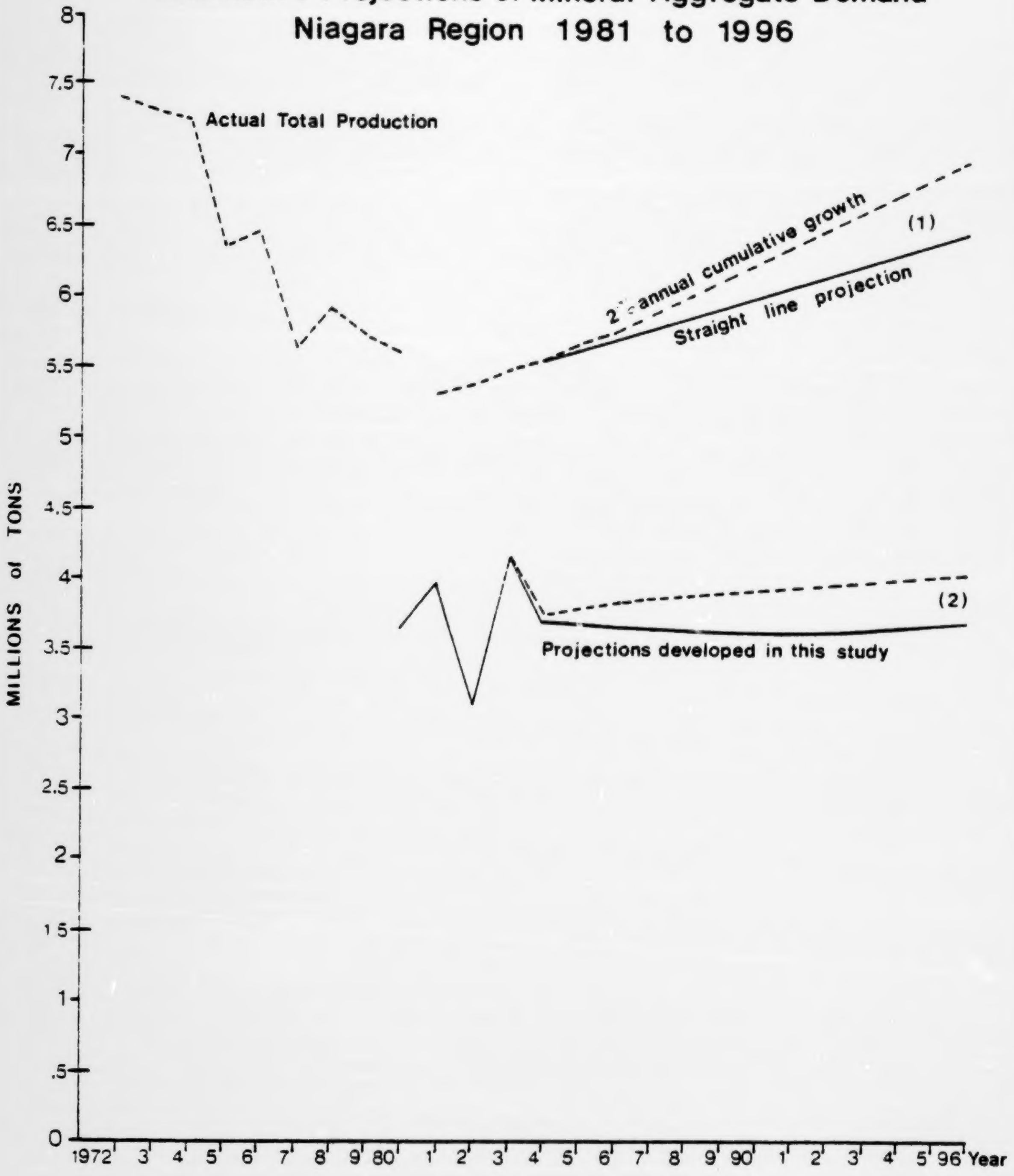
Road engineering accounts for over 67 percent of the cumulative demand. Since road construction is undertaken by governments, changes in expenditure priorities could affect the amount of aggregate required. Overall, the total requirements for mineral aggregate are sensitive to the distribution of the value of construction among the four categories. For instance, a million dollars more of building construction would require only 4,363 more tons of mineral aggregate if used for residential construction or 7,872 tons if non-residential construction. By comparison, a million dollars more on road construction would require 140,870 tons of aggregate. This is for 1971 dollars.

Figure 7.1 compares the projection developed for this study with two recent estimates of demand for mineral aggregate in Niagara from the Ministry of Natural Resources. In reviewing these projections, there are benefits from the information gathered for this study that were unavailable when the Ministry made its projections. Basically, the Ministry's projections over estimate demand in Niagara by underestimating the amount of mineral aggregate exported. While total production has been relatively high as shown on Figure 7.1, around 1.5 million tons or more have been exported annually in the past.

Figure 7.1.a compares the total cumulative demand for mineral aggregate between 1981 and 1996 as projected by the Ministry of Natural Resource and by this present study. The Ministry's projections of total cumulative demand range between 93.5 and 96.7 million tons. The average annual requirement for aggregate would be between 5.8 and 6.0 million tons. The Ministry's cumulative projections are 34.8 million tons (59 percent) to 38 million tons (66 percent) higher for aggregate requirements in Niagara than the one developed in this study. Perhaps one reason why the Ministry overestimated demand in Niagara is the unavailability for review of economic conditions which this present study has endeavoured to provide. This position, however, is understandable as the Ministry is looking at demand projections prepared for a much larger area than just Niagara.

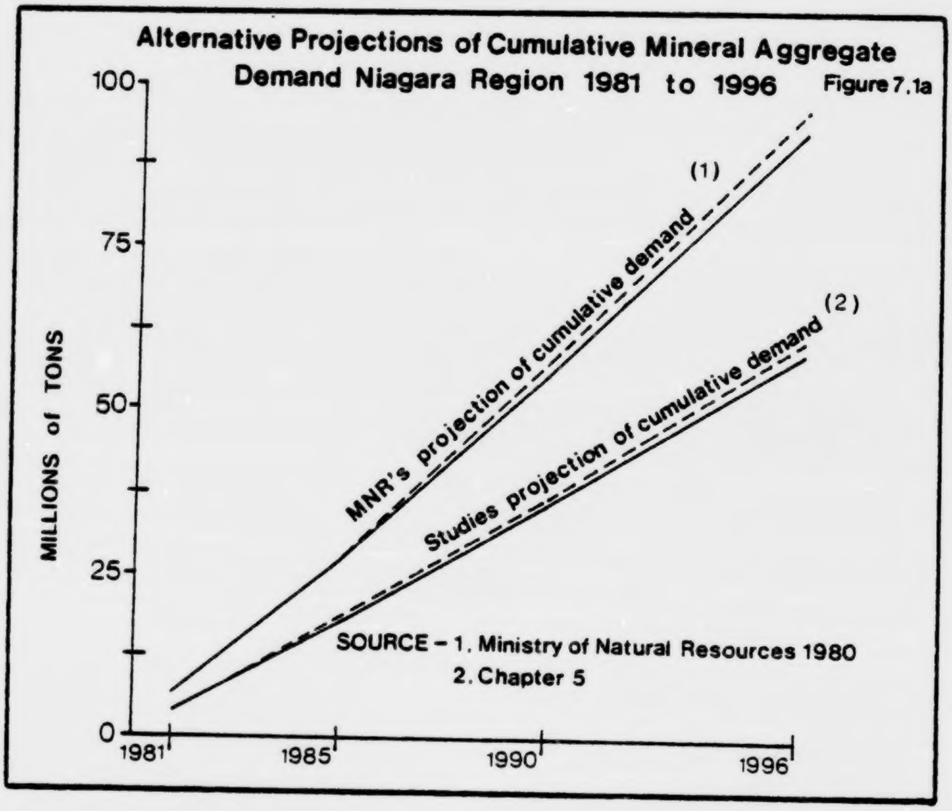
Figure 7.1

Alternative Projections of Mineral Aggregate Demand Niagara Region 1981 to 1996



SOURCE – 1. Ministry of Natural Resources, 1980

2. Chapter 5



Alternative Projections of Cumulative Mineral Aggregate Demand Niagara Region 1981 to 1996 Figure 7.1a

SOURCE – 1. Ministry of Natural Resources 1980
2. Chapter 5

The amount of sand and gravel which will be required from pits is difficult to determine due to the substitution of material from quarries and from dredging. The "input factors" developed for the Ministry of Natural Resource divide aggregate requirements into so many tons of sand and gravel required per $1,000 of construction and similarly so many tons of crushed stone.* This division does not apply in Niagara due to the use of quarry products which in other parts of Ontario may have been provided by pits.

Between 1975 and 1980, sand and gravel represented about 23 percent of the mineral aggregate produced from pits and quarries, and subsequently used in Niagara. If it is assumed that sand and gravel from pits maintains its share of Niagara's market

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* See Mineral Aggregate Study and Geological Inventory Southwestern Region of Ontario, Ontario Ministry of Natural Resources, 1977, Table 4.9, pg. 4.6.

(23 percent), then the total cumulative demand between 1981 and 1996 ranges from 13.5 to 14.0 million tons. This represents an average annual requirement of between 844,000 and 875,000 tons of sand and gravel.

7.1.4 Environmental Assessment

The development of pits for sand and gravel production and, for that matter, quarries, have impacts upon the particular sites and on their surroundings. The opening or extension of a pit is not solely a question of supply and demand. In addition, sand and gravel extraction affects the environment. Consequently, an environmental framework has been developed as a guide in the evaluation of sand and gravel proposals. The framework then is applied in a generalized way to a study area focussed on the Fonthill Kame.

The environmental framework employs the concepts of primary and secondary impacts, and on-site and off-site implications to develop a checklist. This checklist identifies a broad range of issues which could arise from proposed sand and gravel developments. Based on the checklist, information is collected and mapped for the study area to show on three displays: the abiotic (physical), biotic (natural), and cultural/historical (man-made) features. These three displays identify some basic environmental considerations at an area wide level. The display results then are summarized on one map (Integration Display - Figure 7.2) to show the relationship among the various features . This overview of environmental considerations would need to be supplemented by additional information for more detailed application to small areas. The Integration display is discussed later in this chapter.

7.2 Policy Issues

The preceding overview provides common ground now for the consideration of three fundamental policy issues related to:

- resource management,
- future requirements for sand and gravel, and
- conflicts in resource use.

7.2.1 Resource Management

A central theme related to mineral aggregates is that they are a nonrenewable natural resource and an important component of construction - roads, buildings, etc. Therefore, aggregate should not be wasted by being built over and thereby preclude their use. Instead, there should be sequential use with aggregate extraction occuring first then rehabilitation for a suitable after use. On the surface, this is a perfectly reasonable argument which can be applied with equal equity to every pit or quarry application.

The argument applied to individual applications also contains several basic interrelated assumptions including:

a) that any application to extract a nonrenewable resource has merit.

b) that, curiously, extraction is the best method to conserve the resource.

c) that an application signals a community need for the material to be extracted.

d) that additional sites for extraction are equally welcome because of (a), (b) or (c).

e) that other resources such as woodland or agriculture can be rehabilitated back to their present state, if not soon, then at least some time in the future.

Perhaps the above points are a little too hard on the basic argument. Nevertheless, they outline a perception one may obtain.

Surely, resource management is more than sequential use. Rather, resource management should involve a wider range of considerations including resource availability, alternative sources, demand, alternative uses, impacts, and options. Seen in this light, resource management becomes a more challenging task with both economic and environmental dimensions spread over time. It is not one dimensional but involves consideration of the existing and future allocation of resources among often competing uses.

This study on sand and gravel has looked beyond individual applications for extraction in an attempt to provide a broader perspective, a resource management perspective. While the Fonthill Kame continues to stand out as a source of sand and gravel, it is less clear that it is the only option. Products from quarries and from dredging may be able to replace, at least in part, those from pits. Moreover, with the softening in demand for mineral aggregates in Niagara, some breathing space is being provided allowing the opportunity to more fully examine such options as dredging. This does not mean that sand and gravel from the Fonthill Kame is not required for the future. Rather, the study's findings suggest that the demand for aggregates is not as pressing a factor as possibly thought and thus allows for more careful weighing of other factors. By all means, the option for future extraction from the Fonthill Kame should be protected. This should be done through appropriate land use policies in the Regional Niagara Policy Plan, and the Town of Pelham's Official Plan and implementing Zoning By-law. However, the commitment of significant new areas for extraction is questionnable at this time.

7.2.2 Future Requirements for Sand and Gravel

How much sand and gravel is required in Niagara? This has proven to be a very difficult question to answer. Perhaps the question is incorrectly stated. For, as has been observed, material from quarries and from dredging are being used, to some extent, in place of material from pits. This substitution of material from different sources is shown schematically on Figure 7.3.

The "input factors" dividing the amount of aggregates used in construction between sand and gravel, and crushed stone do not apply in Niagara. Far more crushed stone is used here than calculations based on these factors would indicate. The factors, developed for earlier studies sponsored by the Ministry of Natural Resources, appear to be based on actual usage and thus the relative availability of sand and gravel vs. crushed stone across Ontario.

Instead, the question might be rephrased to ask, what products are produced from a pit for which there are no substitutes? Secondly, of these products how much is required in Niagara? A common assertion is that pits are required for the production of concrete sand, a Fine Aggregate. Between 1975 and 1979, concrete sand averaged 50% or 476,000 tons of the total production from Fonthill. Thus, one might conclude that as a minimum approximately 6.8 to 7.0 million tons of concrete sand are required between 1981 and 1996. These figures represent 50% of the estimated total sand and gravel production of 13.5 to 14.0 million tons for this period (based on production from pits retaining 23 percent of Niagara's market as occurred from 1975 to 1979).

There is a number of factors bearing upon the above estimate of 6.8 to 7.0 million tons:

(i) Some concrete sand, the survey of aggregate producers indicates, is provided by dredging and quarries although by far the majority comes from pits.

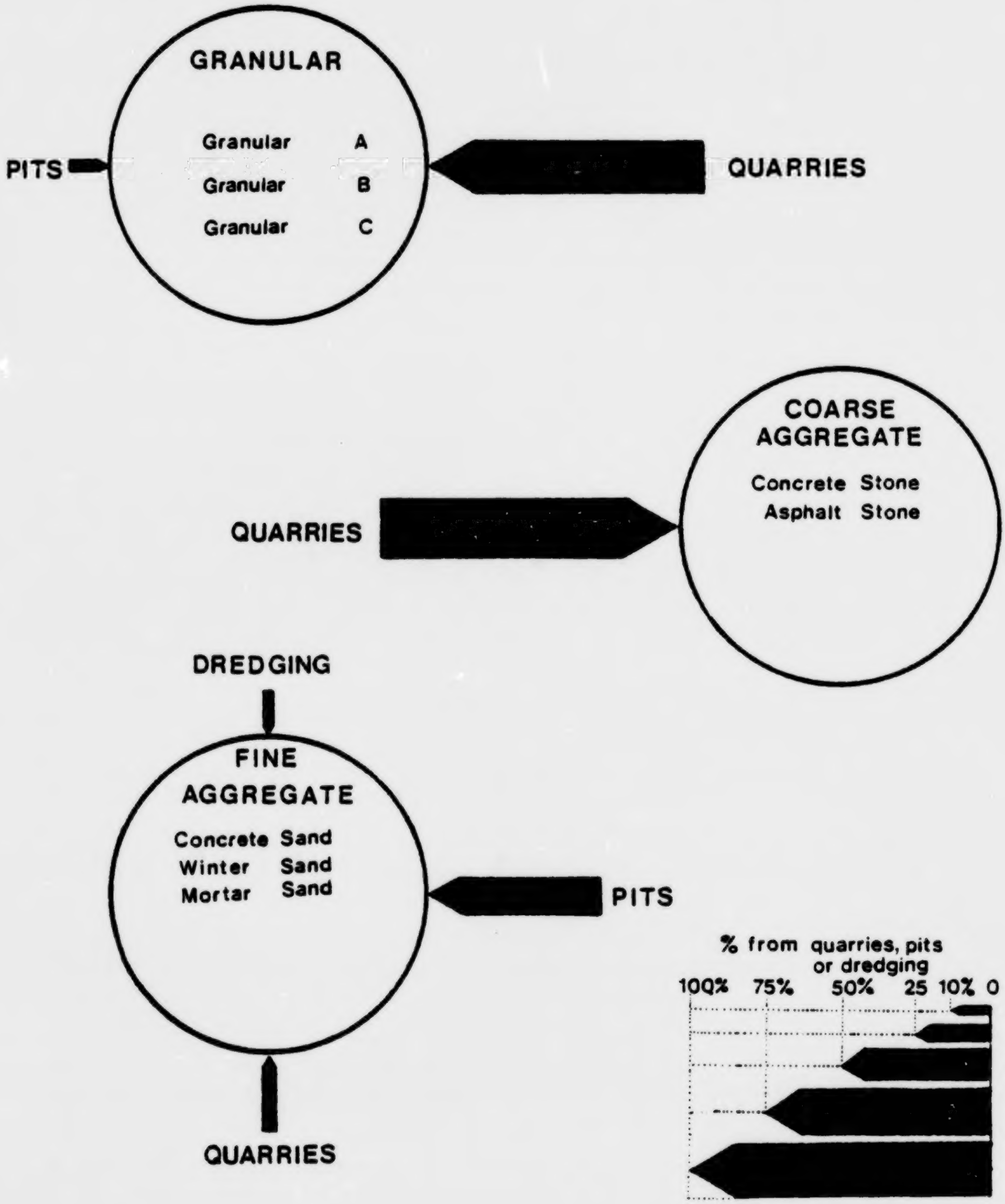
(ii) Natural deposits of sand and gravel do not occur in such a manner as to enable only the production of concrete sand.

(iii) Through processing, it seems that some of the other material produced from a pit such as winter sand might be used for concrete sand. Efforts should perhaps be made to introduce some control to prevent the use of prime aggregate, ie. concrete sand, possibly in a less processed form, for other purposes for which there are other sources.

A tentative conclusion is that more than 7.0 million tons of sand and gravel will be required if for no reason than the fact that not all the material extracted can be processed into concrete sand.

Present Sources of the Main Types of Aggregate Figure 7.3

(Schematic representation)


GRANULAR
Granular A
Granular B
Granular C
PITS
QUARRIES
COARSE AGGREGATE
Concrete Stone
Asphalt Stone
QUARRIES
DREDGING
FINE AGGREGATE
Concrete Sand
Winter Sand
Mortar Sand
PITS
QUARRIES
% from quarries, pits or dredging
100%
75%
50%
25
10%
0

Niagara Region Surveys of
Aggregate Producers and Users

1980

Assuming a 3 to 2 ratio (that is 60% concrete sand to 40% other sand and gravel), then somewhere in the order of 11.3 to 11.7 million tons may be required between 1981 and 1996 out of a total of 13.5 to 14.0 millions tons to enable the production of concrete sand.

In 1976, the Ontario Mineral Aggregate Working Party recommended a general review of forecasting techniques in order to develop more reliable estimates of the future provincial demand for mineral aggregates. This remains an outstanding task despite the recent forecasts from the Ministry reported earlier. More particularly, it is desirable to examine not only total demand but also its components in terms of the different types of aggregate required. Then, there would be a better basis for resource management particularly when tradeoffs are required among different resources. Initial steps have been taken in this direction through this study but more work is probably desirable.

7.2.3 Conflicts in Resource Use

The extraction of aggregate affects other resources. The Fonthill Kame represents a large deposit of sand and gravel. But the area also is noted for its agricultural, tender fruit, and environmental characteristics. Moreover, there are what may be termed common property resources such as clean water and aesthetics which contribute to the quality of the area and surroundings for recreational uses. Thus, there exists a set of interlocking resource relationships. Furthermore, these resources stand out as significant characteristics of the Region.

Chapter 6 and the accompanying maps (Figures 6.1, 6.2 and 6.3) provided some initial information on the land, plant, and man-made features of the Fonthill Kame. Figure 7.2 (also located in the back pocket) illustrates the relationship among these features. Even from this general interpretation, the inter-relationships among resources are noticeable. Consequently, there is the possibility of conflicting land use demands.

Figure 7.2 illustrates the Fonthill Kame as mapped by the Ministry of Natural Resources in relation to three types of categories indicating some level of limitation for future extraction. The first category includes:

- urban development or areas designated for such,
- Short Hills Park Reserve and the St. Johns Conservation Area, and
- existing licensed pits.

Such land uses represent a constraint to future aggregate extraction. Existing licensed pits were included since they are not sites for future extraction once the sand and gravel has been removed.

The second category is represented in general by slopes over 10 percent. This category covers several interrelated environmental considerations such as:

- erosional and water-related impacts,
- impacts on the natural environment including woodlots, and
- possible greater visible aesthetic impacts.

While it is not suggested that the possible impacts associated with aggregate extraction cannot be mitigated, development in areas characterized by steep slopes presents, potentially, a variety of environmental impacts.

The third category on Figure 7.2 shows the existing agricultural land uses. The designation combines the fruit and grape areas with the field and specialty crops as identified on Figure 6.2.

With the integration of these three categories on Figure 7.2, the Fonthill Kame is seen as containing a variety of significant resources. Aggregate extraction would affect one or more of these resources indicating the possibility of requiring tradeoffs. The more resources affected, however, the greater the number of potential conflicts and therefore the increasing difficulty of mitigation.

The answers to conflicting uses of resources are perplexing. While environmental engineering may be helpful in reducing undesirable external effects andfor rehabilitation, such promise however, should not downplay the value of other resources being changed nor the question of need or evaluation of alternatives. Clearly, the provision of sand and gravel, and the use and quality of the environment must be considered as a whole.

7.3 Unanswered Questions

While this study has presented a considerable amount of information on sand and gravel, and aggregates in general, there are five unanswered questions in particular deserving of further inquiry.

7.3.1 Future Production from Dredging

Information gathered here points towards the possibility of greater production of dredged sand and gravel. One estimate calculates a possible reserve of over 120 million tons at the mouth of the Niagara River in Lake Ontario.

Caution should be exercised in reviewing future production from dredging to consider the quality of the material and environmental effects. Also, new or additional landing facilities should be considered if production is to increase significantly.

The Ministry of Natural Resources has given some consideration to a study on dredging. This should be undertaken perhaps with assistance from Regional Niagara.

7.3.2 Future Production from the St. Davids Area

The St. Davids area was once a more important source for sand and gravel. Now it is said that most of the material left is available only for sand fill. Urban-type uses are being proposed for the area by the operators. The Ministry of Natural Resources favours an assessment of the remaining deposits of sand and gravel. This study should be done before future extraction is precluded by urban uses.

7.3.3 Input Factors

The amount of aggregates used by different types of construction, known as input factors, should be reviewed. The factors were developed for 1971. While the Ministry of Transportation and Communications has done some review of the factor for road construction, there was no opportunity to review these four factors during this study. Naturally, if these input factors change, the amount of aggregates required will also change. Changing economic conditions, recycling of pavement, and the use of substitutes for aggregates to name a few items all suggest the desirability of reviewing the four input factors.

7.3.4 Transportation by Rail or Water

The Ministry of Natural Resources funded a study of transporting aggregates by rail or water. This study was expected to be released during the course of this present work. When it is released, the study should be reviewed and reported on as to the possibilities for Niagara.

7.3.5 Planning Policies

The Fonthill Kame represents a large resource of sand and gravel as well as other important resources. Additional urban-type uses such as residential development would affect many of the resources related to the Kame. Therefore, it is desirable for the Town of Pelham together with the Regional Municipality to review the Policy Plan, Official Plan, and Zoning By-law to ensure that the resources will not be affected further by scattered urban-type uses. Such uses can locate in areas designated for them like the Fonthill urban area.

APPENDICES

Appendix 1 Glossary of Terms

Appendix 2 Selected Bibliography

Appendix 3 Questionnaires

Appendix 4 Inventory of Possible Sand and Gravel Resource Areas

Appendix 5 Users Guide to Construction Aggregate

Appendix 1

GLOSSARY OF TERMS

Aggregate	Any hard, inert, construction material (sand, gravel, shells, slag, crushed stone or other mineral material) used for mixing in various sized fragments with a cement or bituminous material to form concrete, mortar, etc., or used alone for road building or other construction.
Coarse Aggregate	Any aggregate which, except for a small percentage, is retained on a 9.52 mm (3/8") square screen mesh. Gravel sizes of 1" and upward usually requires crushing for such uses as road surfacing and concrete.
Crushed Stone	Rock which has been reduced in size by crushing in order to meet consumer requirements.
Deleterious	A general term used to designate those rock types which are chemically or physically unsuited for use as construction or road-building aggregates. Such lithologies as chert, shale, siltstone, and sandstone may deteriorate rapidly when exposed to traffic and other environmental conditions.
Fine Aggregate	This material predominantly passes a 3/8" square screen mesh and is used as a blending product for concrete and hot mix paving.
Fines	A general term used to describe the size fraction of an aggregate which passes (is finer than) the No. 200 mesh screen (0.074 mm). Also described informally as "dirt", these particles are in the silt and clay-size range.
Glaciolacustrine Beach Deposits	These are relatively narrow, linear features formed by wave action at the shores of glacial lakes that existed at various times during the deglaciation of southern Ontario. Well developed lacustrine beaches are usually less than 20 feet (6 m) thick. The aggregate is well sorted and stratified and sand-sized material commonly predominates.

Glaciolacustrine Beach Deposits (cont.)	The composition and size distribution of the deposit depends on the nature of the underlying material. The probability of obtaining crushable aggregate is high when the material is developed from coarse-grained materials such as a stony till, and low when developed from fine-grained materials. Beaches are relatively narrow, linear deposits, so that extractive operations are often numerous and extensive.
Glaciolacustrine Deltas	These features were formed where streams or rivers of glacial meltwater flowed into lakes and deposited their suspended sediment. In southern Ontario such deposits tend to consist mainly of sand and abundant silt. However, in near-ice and ice-contact positions, coarse material may be present. Although deltaic deposits may be large, the probability of obtaining coarse material is generally low.
Granular Base Course	Components of the pavement structure of a road, which are placed on the subgrade and are designed to provide strength, stability, and drainage, as well as support for surfacing materials. Several types have been defined: Granular Base Coarse A consists of crushed and processed aggregate and has relatively stringent quality standards in comparison to Granular Base Coarse B and C which are usually pit-run or other unprocessed aggregate.
Gravel	Unconsolidated granular material produced by the natural disintegration of rock under weathering and erosion processes. Individual grains range in size from approximately 3/8 inch to 3 inches, but the upper limit is not universally applied.
Gross Provincial Product	An economic measure of the total provincial production of goods and services.

Hot-laid or Asphaltic Aggregate	Bituminous, cemented aggregates used in the construction of pavements either as surface or bearing course or as a binder course used to bind the surface course to the underlying granular base course.
Ice Contact Deposits	Land formations whose materials were deposited by meltwaters in direct contact with the glacier. These include eskers, kames, kame-terraces and some end moraines, referred to as kame moraines.
Kames	Kames are defined as mounds of poorly sorted sand and gravel deposited by meltwater in depressions of fissures on the ice surface or at its margin. During glacial retreat, the melting of supporting ice causes collapse of the deposits producing internal structures characterized by bedding discontinuities. The deposits consist mainly of irregularly bedded and cross-bedded, poorly sorted sand and gravel. The present forms of the deposits include single mounds, linear ridges (crevasse fillings) or complex groups of landforms. The latter are occasionally described as "undifferentiated ice-contact stratified drift" when detailed subsurface information is unavilable. Since kames commonly contain large amount of fine-grained material and are characterized by considerable variability, there is generally a low to moderate probability of discovering large amounts of good-quality, crushable aggregate . Extractive problems encountered in these deposits are mainly the excessive variability of the aggregate and the presence of excess fines (silt-and clay-sized particles).
Moraine	Accumulations of drift (materials resulting from direct glacial action) formed as end, terminal or lateral moraines at the margins of the glacier, or as ground moraine under the glacier.

Pit	A place where unconsolidated gravel, stone, sand, earth, clay, fill, mineral or other material is being or has been removed by means of an open excavation to supply material for construction, industrial or manufacturing purposes, but does not include a wayside pit.
Proglacial	That area ahead of a glacier that has been affected by glacial processes.
Quarry	A place where consolidated rock has been or is being removed by means of an open excavation to supply material for construction, industrial or manufacturing purposes, but does not include a wayside quarry.
Re-entrant Valley	A valley created by the headward erosion of a stream.
Sand	Unconsolidated, granular material produced by the natural disintegration of rock under the weathering and erosion processes. Individual grains range in size from .003 inch to .375 inch, with most grains smaller than .187 inch.
Slag	The refuse from the melting of metals or reduction of ores.
Stone	Naturally-occurring rock quarried or mined for industrial use with no change in its chemical state and with its physical character altered only by shaping or sizing.
Till	Unsorted and unstratified rock debris, deposited directly by glaciers, and ranging in size from clay to large boulders.
Washing	Aggregates can be cleaned by washing to remove coatings of silt or clay (fines) from individual particles. This process improves the surface bonding and adhesion properties of the aggregates with different admixtures, such as cement paste.

Wayside Pit or Wayside Quarry	A temporary pit or quarry opened and used by a public road authority solely for the purpose of a particular project or contract of road construction and not located on the road right of way.

Appendix 2

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Appendix 3

QUESTIONNAIRES

Completed by: ____________________

Date: ____________________

*NOTE: Additional Information, Comments, or Questions, Please Use Reverse Side.

The Regional Municipality of Niagara

Study of The Supply and Demand for Sand and Gravel

Aggregate Producers' Information (November 21, 1980)

Niagara

Company Name ____________________ Location of Pit/Quarry ________ Lot ________ Concession ________ Municipality ________

Usage of Sand and Gravel (In Tons)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1 Using the Chart below, please answer the following 3 questions: (Please complete as many years as possible). i) Types and quantities of materials produced (eg. x tons of granular A, y tons of concrete sand, z tons of granular c) ii) Average price per ton of each product (ie. freight on board). iii) Average transportation cost to the customer (ie. cost per ton per mile) Material Type											
a) ____________ i) Tonnage											
ii) Price(f.o.b.)											
iii) Cost											
b) ____________ i) Tonnage											
ii) Price(f.o.b.)											
iii) Cost											
c) ____________ i) Tonnage											
ii) Price(f.o.b.)											
iii) Cost											
d) ____________ i) Tonnage											
ii) Price(f.o.b.)											
iii) Cost											
e) ____________ i) Tonnage											
ii) Price(f.o.b.)											
iii) Cost											
f) ____________ i) Tonnage											
ii) Price(f.o.b.)											
iii) Cost											
g) ____________ i) Tonnage											
ii) Price(f.o.b.)											
iii) Cost											
h) ____________ i) Tonnage											
ii) Price(f.o.b.)											
iii) Cost											
2. Total amount produced											
3. i) Do you have the capacity to produce more material with your present processing plant? (Please circle yes or no) ii) If yes to the above, how much?										Yes - No	Yes - No
4. What percentage of the total annual production was sold in the following geographic areas: a) Within Niagara Region? b) Within Hamilton-Wentworth Region? c) Within Haldimand-Norfolk Region? d) Other Ontario? e) Exported (directly or indirectly) to the U.S.A.?						a b c d e					

Over

Side 2

Usage of Sand and Gravel (in Tons)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
5. What percent of the total annual production was: (i) Sold to the following consumer groups:											
a) Municipalities											
b) Provincial Agencies											
c) Contractors											
d) Asphalt, concrete block and Ready Mix											
e) Builder's Supply Companies											
f) Other Industry											
g) Others (Please specify)											
(ii) Used internally?											
Total						100%	100%	100%	100%	100%	100%
6. What percentage of the total annual production was: (i) transported by the company to the consumer via the following modes:											
a) Truck?											
b) Railway?											
c) Ship?											
(ii) What percentage of the total annual production was directly purchased by the consumer at the gate.											

2

7. Total licensed acreage held. (please correct if necessary) → acres

8. Total licensed acreage already exhausted by extraction. → acres

9. Total licensed acreage still available for extraction. → acres

10. i) Estimate the quantities of materials remaining within the licensed "economic" (recoverable) reserve area (ie. less reserves lost to legal setbacks, presence of fines, etc.) → Tons

ii) Estimate the life expectancy of the licensed reserve (in years) → Years

3

Please answer the following 2 questions in the space provided:

11. What problems or limitations do you have with your operations and materials? (eg. Limitations on processing, mixture of coarse and fine materials, etc.)

Answer

12. We would appreciate any comments you may have concerning the aggregate industry's future in Niagara. (eg. future markets, demand, regulations, etc.)

Answer

Additional Information or Comments:

Questions:

or Please Contact:

Paul Chapman or Ken Forgeron at 685-1571, Ext. 297
The Regional Municipality of Niagara
Planning and Development Department
P. O. Box 3025
150 Berryman Avenue
St. Catharines, Ontario
L2R 7E1

unicipality ________
ompleted by: ________
ate: ________

NOTE: Additional Information, Comments, or Questions, Please Use Reverse Side.

The Regional Municipality of Niagara
Study of The Supply and Demand for Sand and Gravel
Municipal Information (October 17, 1980)

Usage of Sand and Gravel (in Tons)	1975		1976		1977		1978		1979		1980	
1. Total amount purchased												
2. Types and quantities of materials purchased (eg. x tons of granular A, y tons of winter sand, etc.) from each supplier. Also indicate the source of this material (eg. Name of quarry or pit and location).	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)
I Supplier ________												
Material Type and quantity a) ________												
b) ________												
c) ________												
d) ________												
e) ________												
TOTAL ________												
II Supplier ________												
Material Type and quantity a) ________												
b) ________												
c) ________												
d) ________												
e) ________												
TOTAL ________												
III Supplier ________												
Material Type and quantity a) ________												
b) ________												
c) ________												
d) ________												
e) ________												
NOTE: If there are other suppliers please list information on reverse side												
3. Quantity used in each of the following categories:	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)
A. Building construction (eg. institutional, industrial, etc.) ________												
B. Non-road engineering construction (eg. sewer lines, etc.) ________												
C. Road engineering construction (including maintenance) ________												
D. Road sanding in winter ________												
E. Other Uses												
i) ________												
ii) ________												
(iii)												
4. Are any municipal construction or sanding works contracted out to private firms? (Please circle yes or no) → NOTE: If you have answered yes to question No. 4 above then please answer questions 2 and 3 of this questionnaire again for contracted work. IF POSSIBLE, PLEASE PROVIDE ESTIMATES WHERE ACTUAL QUANTITIES ARE NOT AVAILABLE.	YES — NO		YES — NO		YES — NO		YES — NO		YES — NO		YES — NO	
5. Does the municipality use wayside pits or quarries as a source of supply? (Please circle yes or no) →	YES — NO		YES — NO		YES — NO		YES — NO		YES — NO		YES — NO	
NOTE: If you have answered yes to question No. 5 then please answer the following.												
5.1 How much material is used?												
5.2 What was this material used for? (Refer to question #3 for type of use)												

Side 2

Information on Additional Suppliers

Usage of Sand and Gravel (in Tons)	1975		1976		1977		1978		1979		1980	
	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)	MUNICIPAL	CONTRACTED (see Question 4)
Types and quantities of materials purchased (eg. x tons of granular A, y tons of winter sand, etc.) from each supplier. Also indicate the source of this material (eg. Name of quarry or pit and location).												
IV Supplier ________												
Material Type and quantity a) ________												
b) ________												
c) ________												
d) ________												
e) ________												
TOTAL ____												
V Supplier ________												
Material Type and quantity a) ________												
b) ________												
c) ________												
d) ________												
e) ________												
TOTAL ____												
VI Supplier ________												
Material Type and quantity a) ________												
b) ________												
c) ________												
d) ________												
e)												

Additional Information or Comments:

Questions:

or Please Contact:

Paul Chapman or Ken Forgeron at 685-1571, Ext. 297
The Regional Municipality of Niagara
Planning and Development Department
P. O. Box 3025
150 Berryman Avenue
St. Catharines, Ontario
L2R 7E1

The Regional Municipality of Niagara

Study of The Supply and Demand for Sand and Gravel
Municipal Information

Niagara

Company ______________________
Municipality ______________________
Completed by: ______________________
Date: ______________________

Usage of Sand and Gravel (in Tons)	1979	1980
1. Total amount purchased		
2. Types and quantities of materials purchased (eg. x tons of granular A, x tons of sand, etc.) from each supplier. Also indicate the source of this material (eg. Name of quarry or pit and location).		
I Supplier ______		
Material Type and quantity a) ______		
b) ______		
c) ______		
d) ______		
e) ______		
TOTAL ______		
II Supplier ______		
Material Type and quantity a) ______		
b) ______		
c) ______		
d) ______		
e) ______		
TOTAL ______		
III Supplier ______		
Material Type and quantity a) ______		
b) ______		
c) ______		
d) ______		
e) ______		
3. How much and what products did you produce using Sand and Gravel?		
a) ______		
b) ______		
c) ______		
d) ______		
4. What percentage of your 1980 production was sold in each of the following market areas?		
a) Within the Niagara Region		
b) Within Hamilton-Wentworth		
c) Within Haldimand-Norfolk		
d) Other areas in Ontario		
e) U.S.A.		
5. What percentage of the final selling price of your products does the cost of sand and gravel inputs represent?		
a) ______		
b) ______		
c) ______		
d) ______		

PLEASE RETURN TO:

Regional Municipality of Niagara
Planning Department
P. O. Box 3025 - 150 Berryman Avenue
St. Catharines, Ontario
L2R 7E9

Appendix 4

INVENTORY OF
POSSIBLE
SAND AND GRAVEL
RESOURCE
AREAS

Maps and Descriptions of the Possible Sand and Gravel Resource Areas in Niagara

Notes

1) The key map of the entire Niagara Region on the following page identifies the locations of 28 maps which show the location of the possible sand and gravel resource areas.

2) Quantitative estimates of the resource supply which may be available in each possible sand and gravel deposit have been made by Regional staff using the commonly-accepted "Resource Tonnage Calculation Technique" approach of the Ministry of Natural Resources which is:

   Tonnage = Area x Thickness x Density Factor

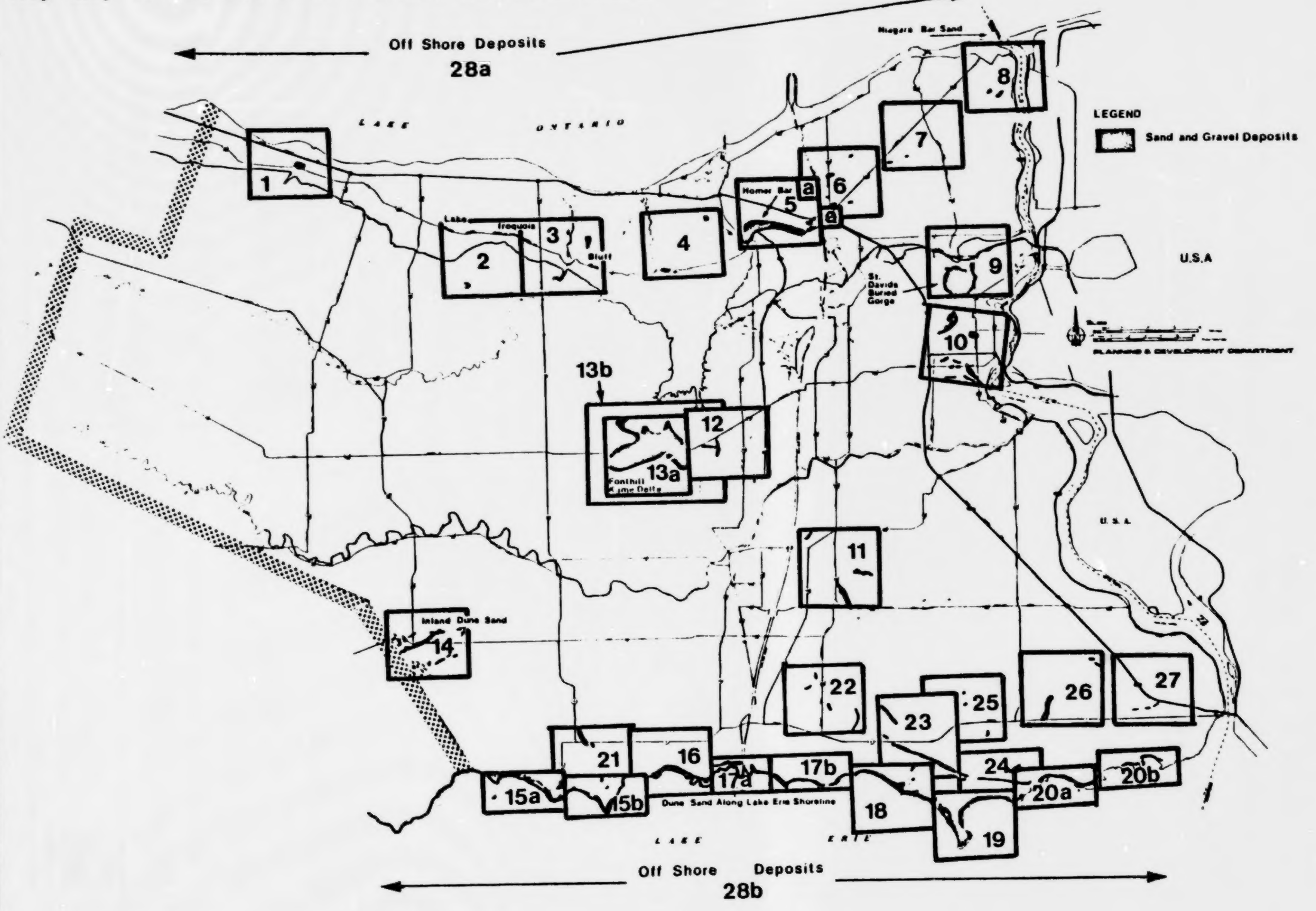
   Tonnage values are calculated in the following way:

   The area of the deposit is calculated in acres and then multiplied by the approximate deposit thickness to arrive at the volume of the deposit. This value is multipled by the density factor for sand and gravel (2500 tons/acre/foot) which is the number of tons in a one-foot thick layer of sand and gravel, one acre in extent, assuming an average density of 110 pounds per cubic foot.

   The estimates provided in the description for each inventory sheet exclude any known physical constraints to development of the deposits (e.g. houses, cemeteries, road beds, etc.), but the calculations do not take into account other plans which may restrict develoment (e.g. zoning by-laws, required setbacks, etc.)

   The Ministry of Natural Resources considers those deposits thicker than 20 feet and containing more than 35% of crushable gravel to be most favourable for commercial development. However, thinner deposits may be valuable in municipalities with low total resources. Data on the amounts of crushable material available in each deposit were not available in all cases.

Key Map of Possible Sand & Gravel Resource Areas

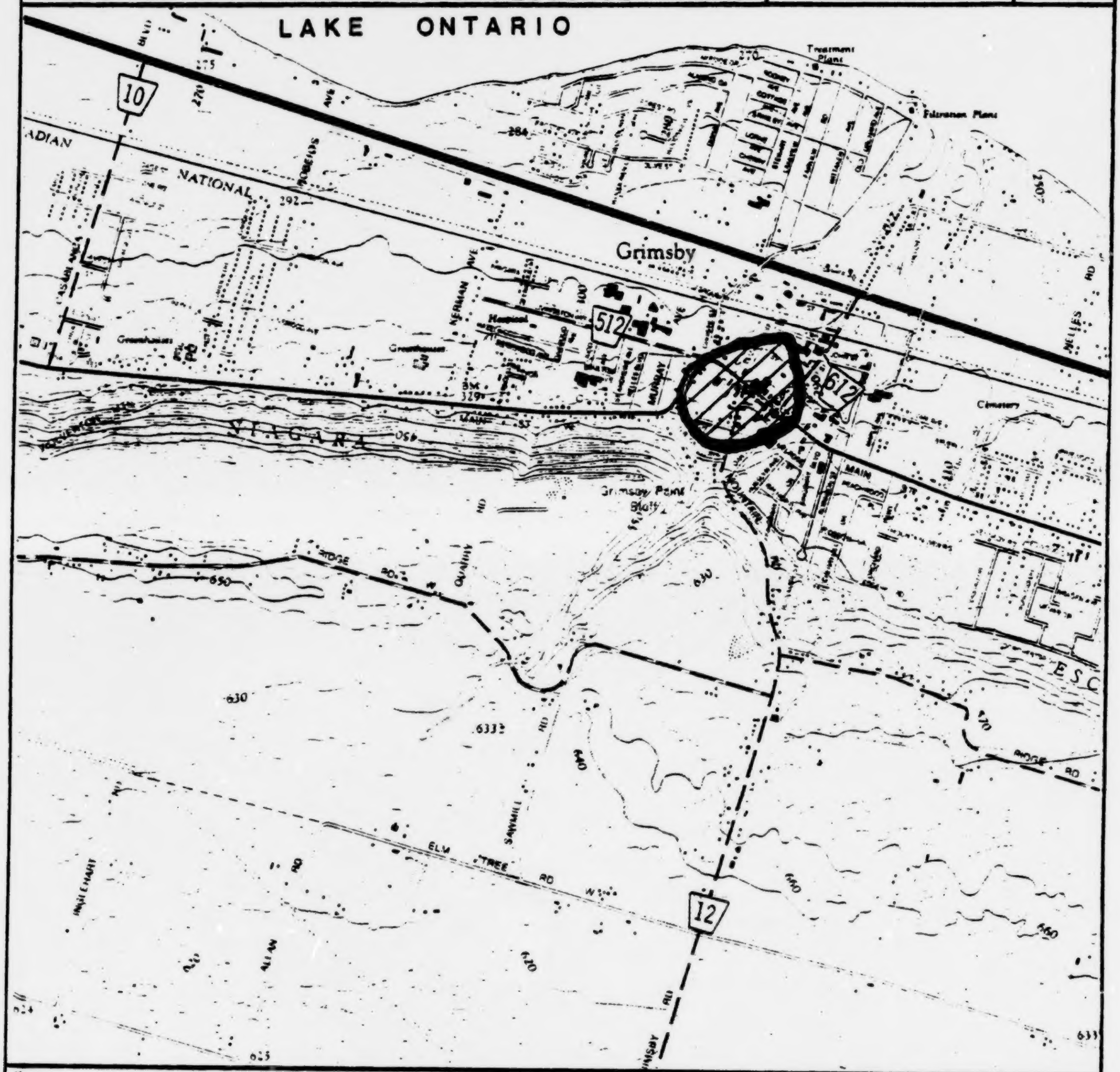

Off Shore Deposits
28a
Niagara Bar Sand
LAKE ONTARIO
LEGEND
Sand and Gravel Deposits
U.S.A
PLANNING & DEVELOPMENT DEPARTMENT
U.S.A.
1
2
3
Lake Iroquois Bluff
4
Homer Bar
5
a
6
a
7
8
9
St. Davids Buried Gorge
10
11
12
13a
13b
Fonthill Kame Delta
14
Inland Dune Sand
15a
15b
16
17a
17b
18
19
20a
20b
21
22
23
24
25
26
27
Dune Sand Along Lake Erie Shoreline
LAKE ERIE
Off Shore Deposits
28b

NIAGARA SAND AND GRAVEL STUDY

POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
GRIMSBY

1
SHEET NO


LAKE ONTARIO
10
Grimsby
512
512
NIAGARA
ESC
Grimsby Point Bluffs
RIDGE RD
ELM TREE RD
12
Treatment Plant
Filtration Plant
Cemetery
Greenhouses
MAIN
630
640
650

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1 : 24,000 (1" : 2,000') (1cm : 240m)

April 1981

☐ 10 Acres Approx (4 ha approx.)

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 1

Municipality Grimsby

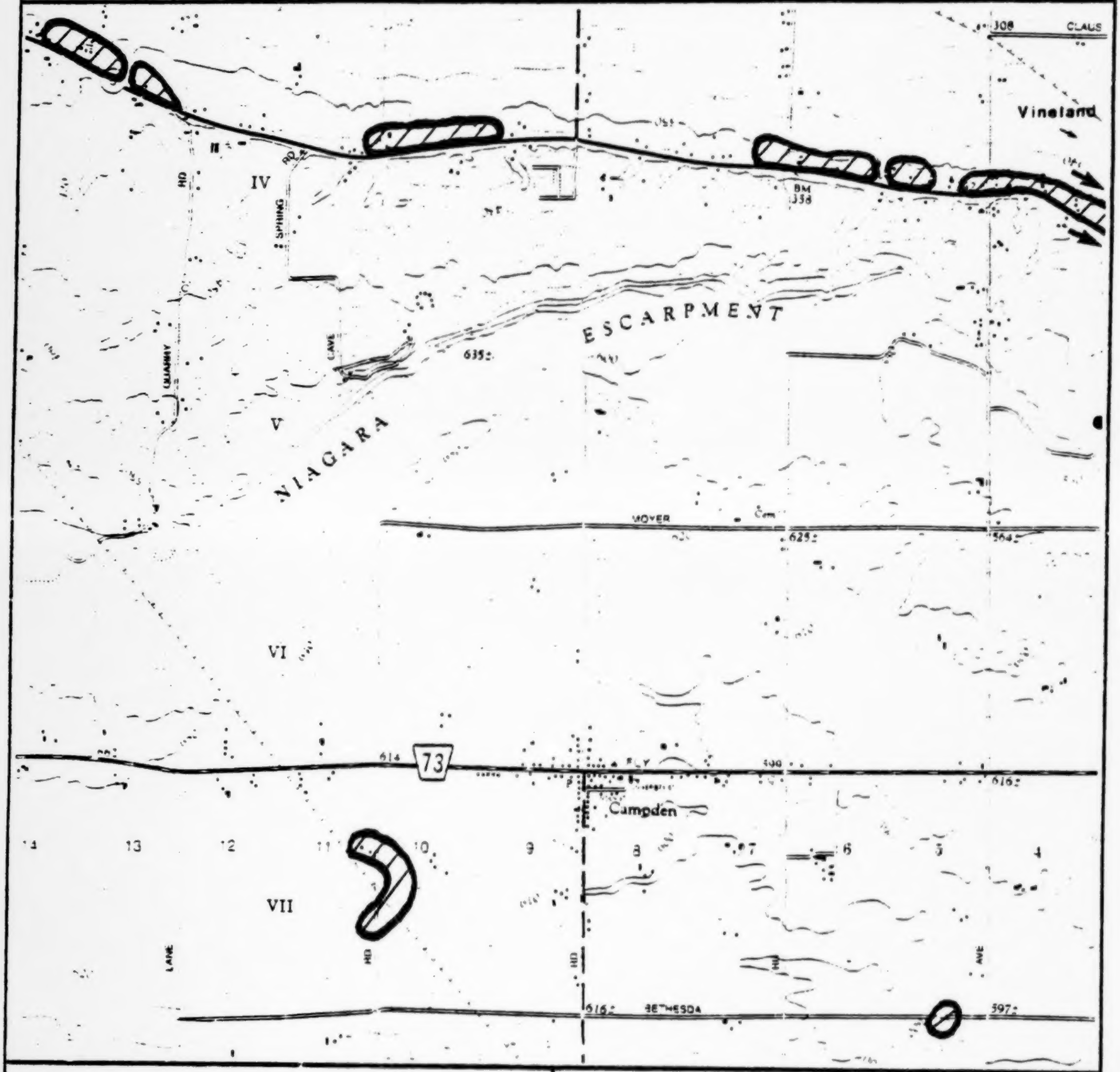
A small gravel deposit is located in the core of downtown Grimsby. Geologically this is an alluvial fan deposit which formed at the mouth of the gorge cut into the Niagara Escarpment by the Forty Mile Creek and is below the former level of proglacial Lake Iroquois.

Since all of the deposit is covered by urban development future extraction in this area is unlikely.

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
LINCOLN

2
SHEET NO


308
CLAUS
Vineland
IV
SPRING RD
BM
358
QUARRY
CAVE
635
NIAGARA ESCARPMENT
V
MOYER
Cem
625
564
VI
614
73
FLY
616
Campden
14
13
12
11
10
9
8
7
6
5
4
VII
LANE
RD
RD
AVE
616
BETHESDA
597

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1 : 24,000 (1" : 2,000') (1cm : 240m)

FEET 1000 0 1000 2000 3000 4000

METRES 300 0 300 1000

April 1981

☐ 10 Acres Approx (4 ha approx.)

N

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 2

Municipality Lincoln

Six small linear deposits are located along the north side of Regional Road #81 between the communities of Beamsville and Vineland. Geologically they are Lake Iroquois beach and bar deposits generally composed of gravelly sand and gravel about 4 to 5 feet in depth.

The deposits, excluding the existing development, cover about 25 acres and may contain between 250,000 and 350,000 tons of material. The exact amount and potential uses are unknown. However, some way-side pit activity may be possible. Constraints to development of these deposits may include houses in the area, roads, orchards and vineyards.

Two small stratified sand and gravel deposits are also located south of Campden. Geologically they are Lake Warren and younger pre-Iroquois beach and bar deposits about 3 feet in depth.

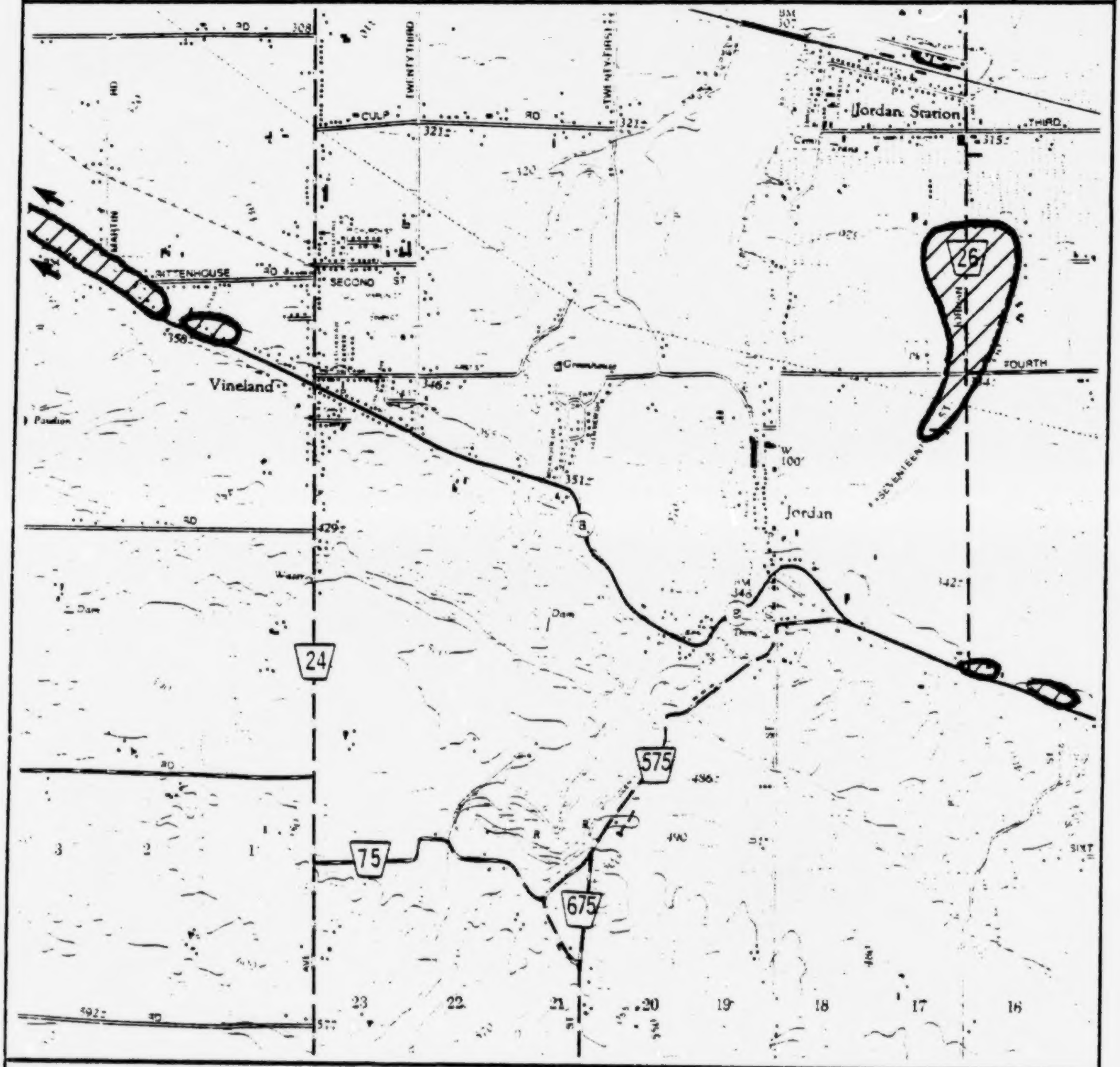
These deposits, excluding the existing development, cover about 10 acres and may contain between 50,000 and 100,000 tons of material. The exact amount and potential uses are unknown. However, some way-side pit activity may be possible.

Constraints to development of these deposits may include houses in the area, roads and a Bell telephone line.

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
LINCOLN

3
SHEET NO


RD
308
TWENTY THIRD
TWENTY-FIRST
BM 307
Jordan Station
THIRD
CULP
RD
321
315
320
MARTIN
RITTENHOUSE
RD
SECOND
ST
26
358
Vineland
346
Greenhouse
FOURTH
Pavilion
351
8
100
Jordan
SEVENTEEN
RD
429
Dam
BM 346
8
342
24
575
75
675
RD
SIXT
3
2
1
23
22
21
20
19
18
17
16
592
RD
577

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Legend

Licensed Sand and Gravel Pits ⚒

Possible Resource Areas ▨

SCALE 1:24,000 (1" : 2,000') (1cm : 240m)

FEET 1000 0 1000 2000 3000 4000

METRES 500 0 500 1000

Niagara

The Regional Municipality of Niagara
Planning and Development Department

April 1981

☐ 10 Acres Approx
(4 ha approx.)

N

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 3

Municipality Lincoln

Three small deposits are located east of the community of Jordan. Geologically they are Lake Iroquois beach and bar deposits of gravel and gravelly sand about 3 to 4 feet in depth.

The deposits, excluding the existing development, cover about 38 acres and may contain between 250,000 and 350,000 tons of material. The exact amount and potential uses are unknown.

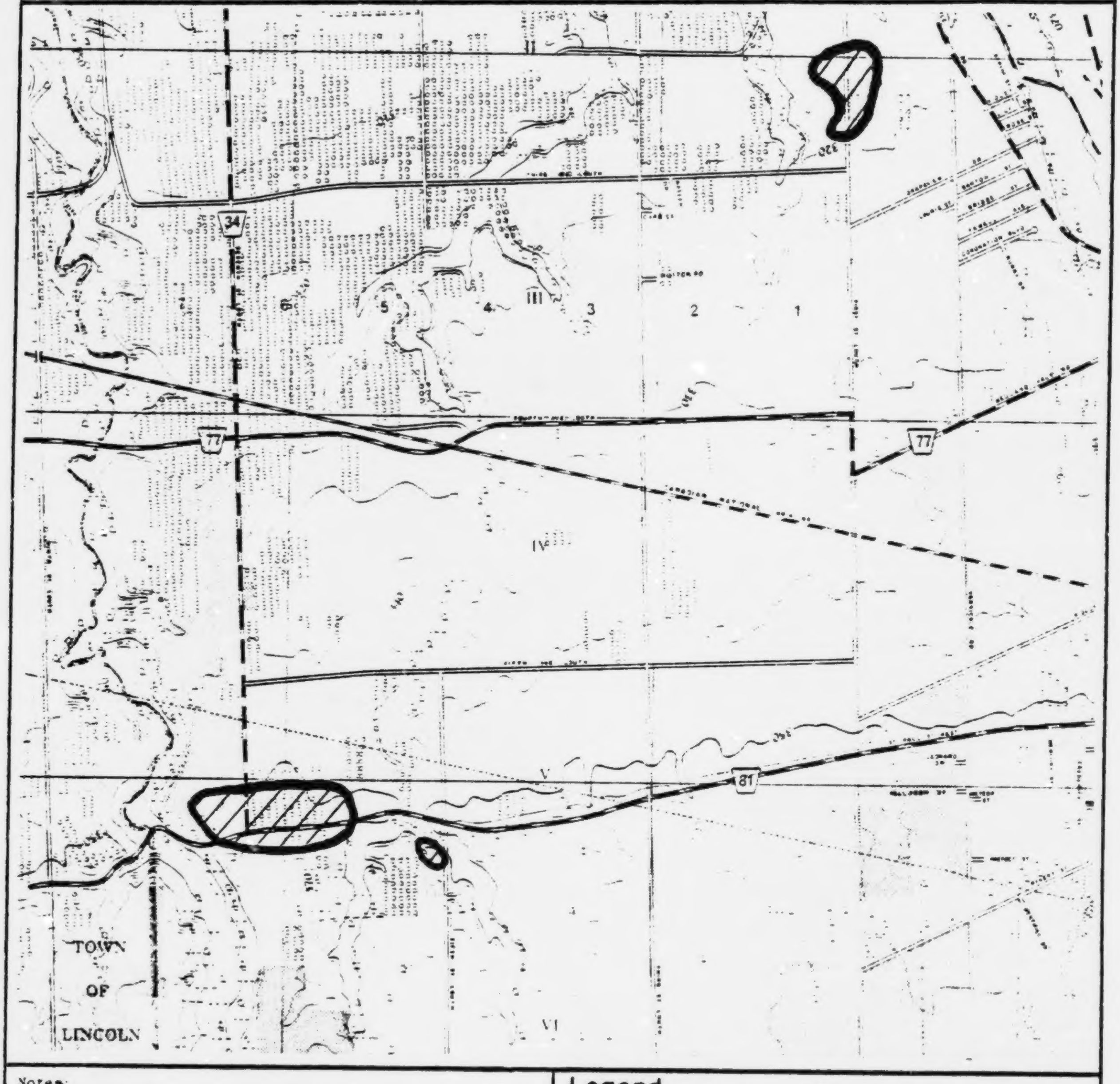
Constraints to development of these deposits may include houses in the area, roads, orchards, vineyards and an arena-community center facility.

Two small linear deposits are also located west of Vineland along the Lake Iroquois shoreline. These deposits are similar to those described above but since they are substantially covered by urban development their potential for any extraction is severely limited.

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
ST. CATHARINES

4
SHEET NO



Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1:24,000 (1" = 2,000') (1cm : 240m)

April 1981

☐ 10 Acres Approx (4 ha approx.)

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 4

Municipality St. Catharines

Three very small deposits are located on the west side of St. Catharines. The deposits geologically, are Lake Iroquois beach and bar deposits of gravel and gravelly sand about 4 feet in depth.

The deposits, excluding the existing development, cover about 23 acres and may contain between 150,000 and 250,000 tons of material. The exact amount and potential uses are unknown. However, some wayside pit activity may be possible.

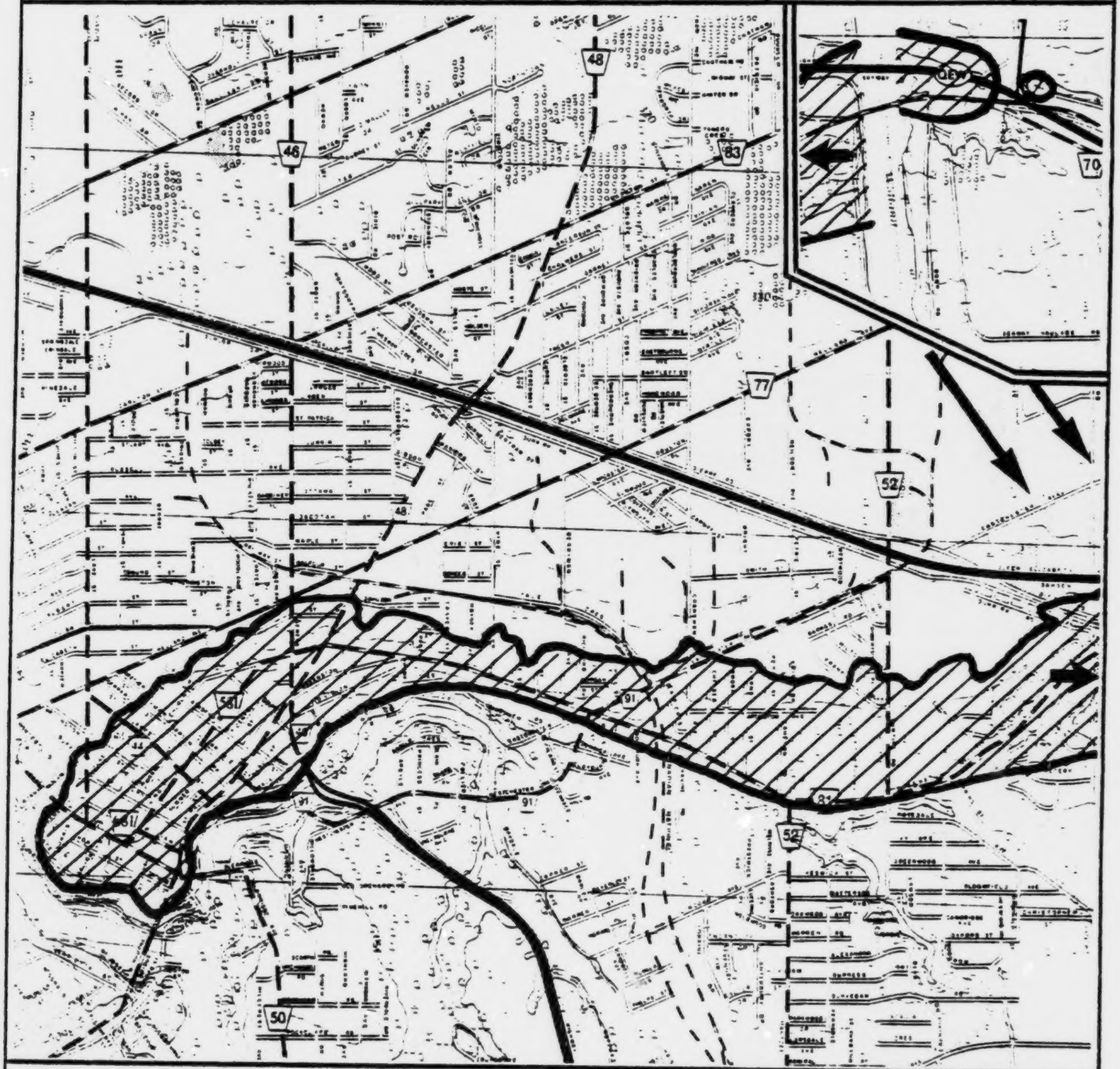
Constraints to development of these deposits may include houses in the area, roads, orchards, vineyards, a nursery, and a store.

NIAGARA SAND AND GRAVEL STUDY

POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
ST. CATHARINES

5
SHEET NO



Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1 : 24,000 (1" = 2,000') (1cm = 240m)

April 1981

☐ 10 Acres Approx (4 ha approx.)

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 5

Municipality St. Catharines

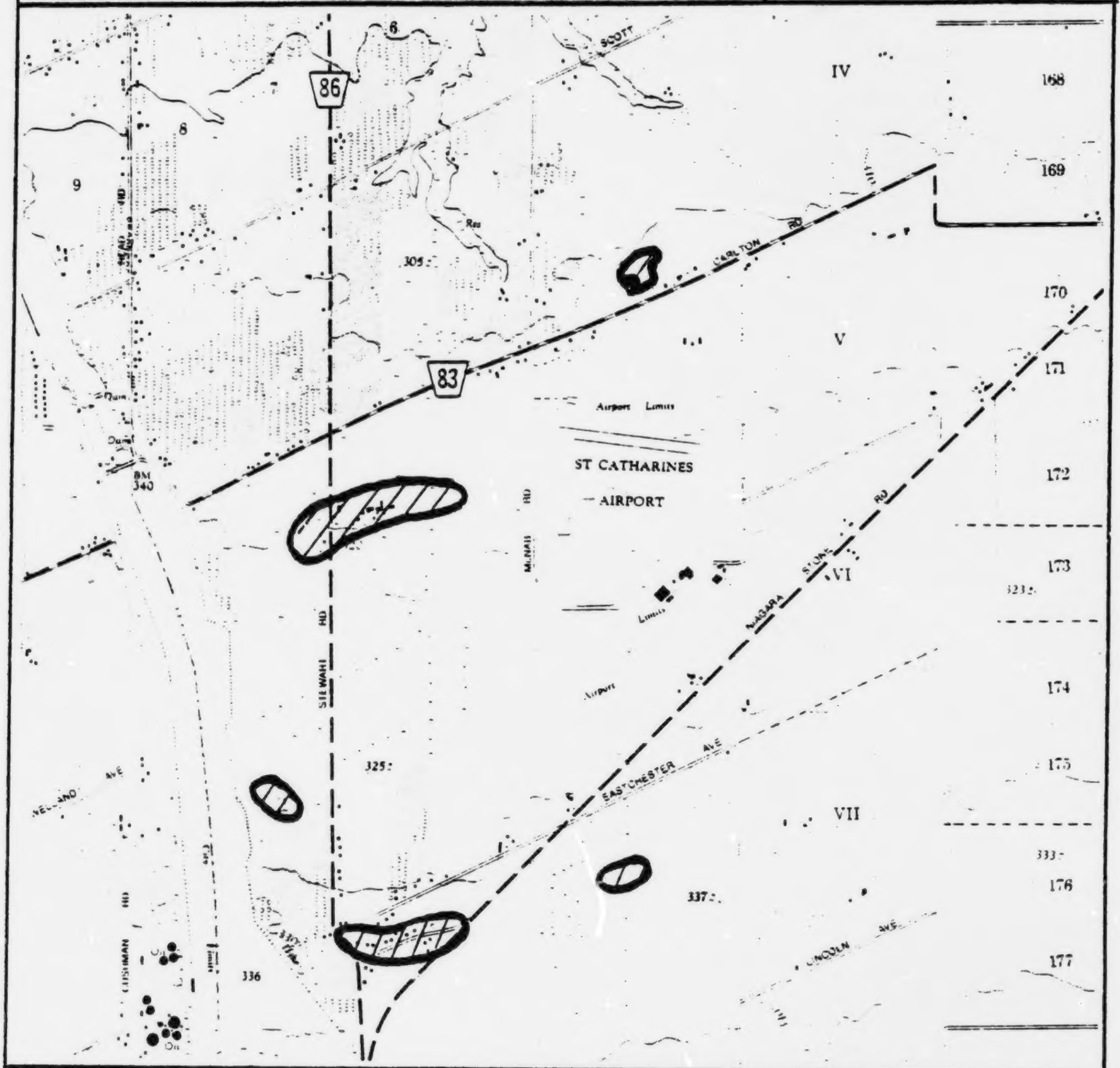
The largest of all the Lake Iroquois beach and bar deposits in Niagara is the Homer Bar situated in the City of St. Catharines. These deposits consist of gravelly sand and gravel extending to a depth of about 25 feet.

The Ministry of Natural Resources has identified this bar as the only major commercial source of sand and gravel on the Iroquois Plain and estimates reserves at about 8 million tons. However, since most of this deposit is covered by urban development future extraction in this area is unlikely.

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
NIAGARA-ON-THE-LAKE

6
SHEET NO


6
SCOTT
IV
168
86
7
8
9
169
Res
305
CARLTON RD
170
V
171
83
Airport Limits
ST CATHARINES
AIRPORT
172
Dam
BM 340
McNAB RD
173
VI
NIAGARA STONE RD
323
Limits
STEWART RD
Airport
174
325
EASTCHESTER AVE
175
NELSON AVE
VII
333
176
337
LINCOLN AVE
177
336
CUSHMAN RD
Oil

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Legend

Licensed Sand and Gravel Pits ⚒

Possible Resource Areas ▨

SCALE 1:24,000 (1" = 2,000') (1cm = 240m)

FEET 1000 0 1000 2000 3000 4000

METRES 300 0 300 1000

Niagara

The Regional Municipality of Niagara
Planning and Development Department

April 1981

☐ 10 Acres Approx
(4 ha approx.)

N

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 6

Municipality Niagara-on-the-Lake

Five small deposits are located in the vicinity of Niagara District Airport. Geologically they are Lake Iroquois beach and bar deposits of gravelly sand and gravel ranging from 3 to 8 feet in depth.

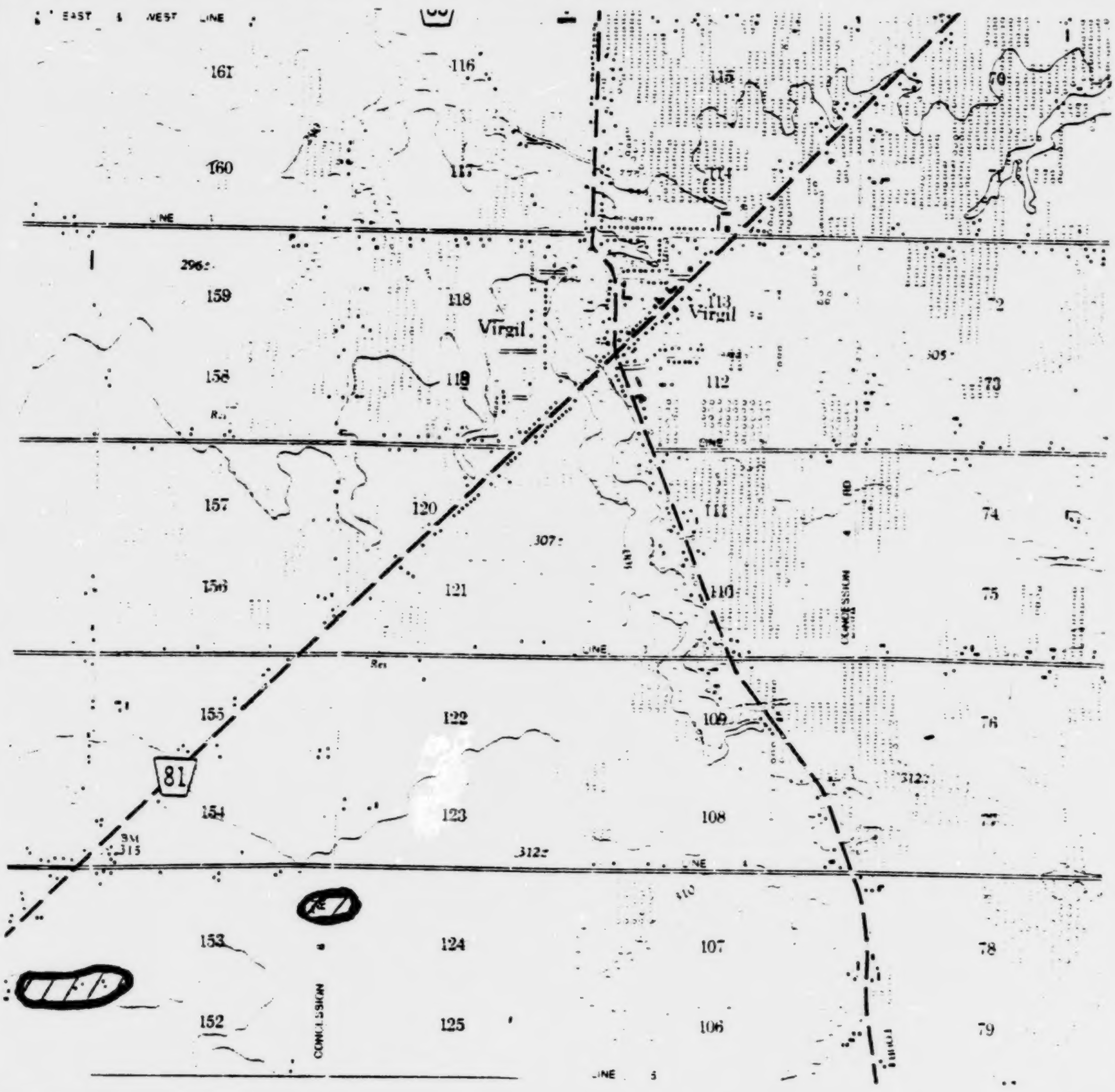
The deposits, excluding the existing development, cover about 40 acres and may contain between 350,000 and 450,000 tons of material. The exact amount and potential uses are unknown but some wayside pit activity may be possible.

Constraints to development of these deposits may include houses, roads, a dairy operation and a small creek (the Eight Mile Creek).

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
NIAGARA-ON-THE-LAKE

7
SHEET NO


EAST & WEST LINE
161
116
115
70
160
117
114
LINE
296
159
118
Virgil
113
Virgil
72
158
119
112
305
73
RD
LINE
157
120
111
74
307
156
121
110
CONCESSION
75
LINE
RD
155
122
109
76
81
154
123
108
312
77
BM 315
312
LINE
153
124
107
78
152
CONCESSION
125
106
79
LINE 5

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Legend

Licensed Sand and Gravel Pits ⚒

Possible Resource Areas ▨

SCALE 1 : 24,000 (1" : 2,000') (1cm : 240m)

Niagara

The Regional Municipality of Niagara
Planning and Development Department

April 1981

☐ 10 Acres Approx (4 ha approx.)

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 7

Municipality Niagara-on-the-Lake

Two small deposits are located southwest of the Virgil community. Geologically they are Lake Iroquois beach and bar deposits of gravelly sand which range from 2 to 5 feet in depth.

The deposits, excluding the existing development, cover about 18 acres and may contain between 100,000 and 150,000 tons of material. The exact amount and potential uses are unknown. However, some wayside pit activity may be possible.

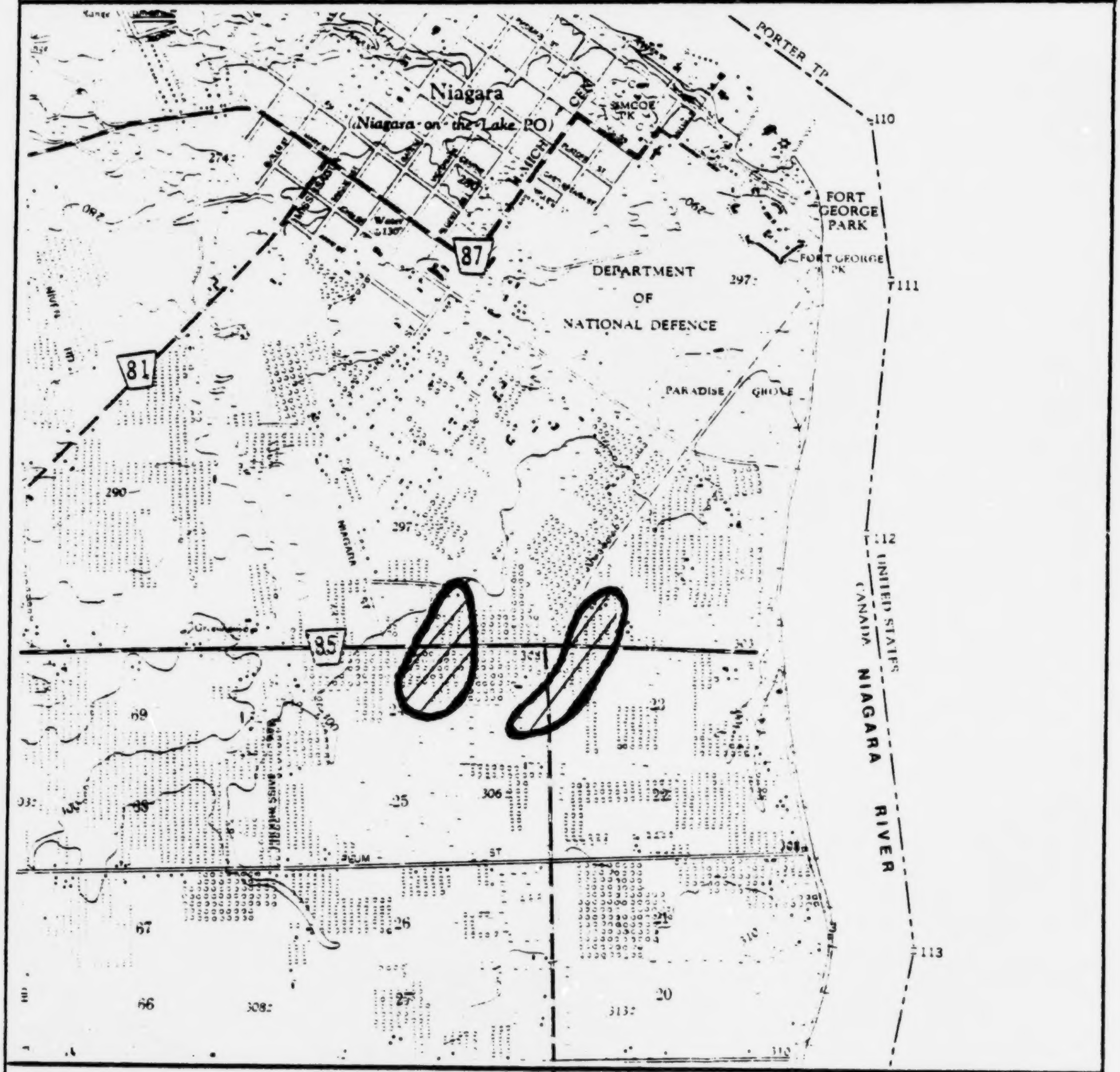
Constraints to development of these deposits may include houses in the area, agricultural activities and roads.

NIAGARA SAND AND GRAVEL STUDY

POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
NIAGARA-ON-THE-LAKE

8
SHEET NO


Niagara
(Niagara-on-the-Lake PO)
SIMCOE PK
PORTER TP
110
FORT GEORGE PARK
FORT GEORGE PK
87
DEPARTMENT OF NATIONAL DEFENCE
297
111
81
PARADISE GROVE
290
274
297
112
UNITED STATES
CANADA
NIAGARA RIVER
85
69
25
306
22
21
26
27
20
66
67
308
313
113

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1:24,000 (1" = 2,000') (1cm = 240m)

April 1981

☐ 10 Acres Approx (4 ha approx.)

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 8

Municipality Niagara-on-the-Lake

Two small deposits are located south of the old Town of Niagara-on-the-Lake. Geologically, they are Lake Iroquois beach and bar deposits consisting of gravel and gravelly sand ranging from 3 to 12 feet in depth.

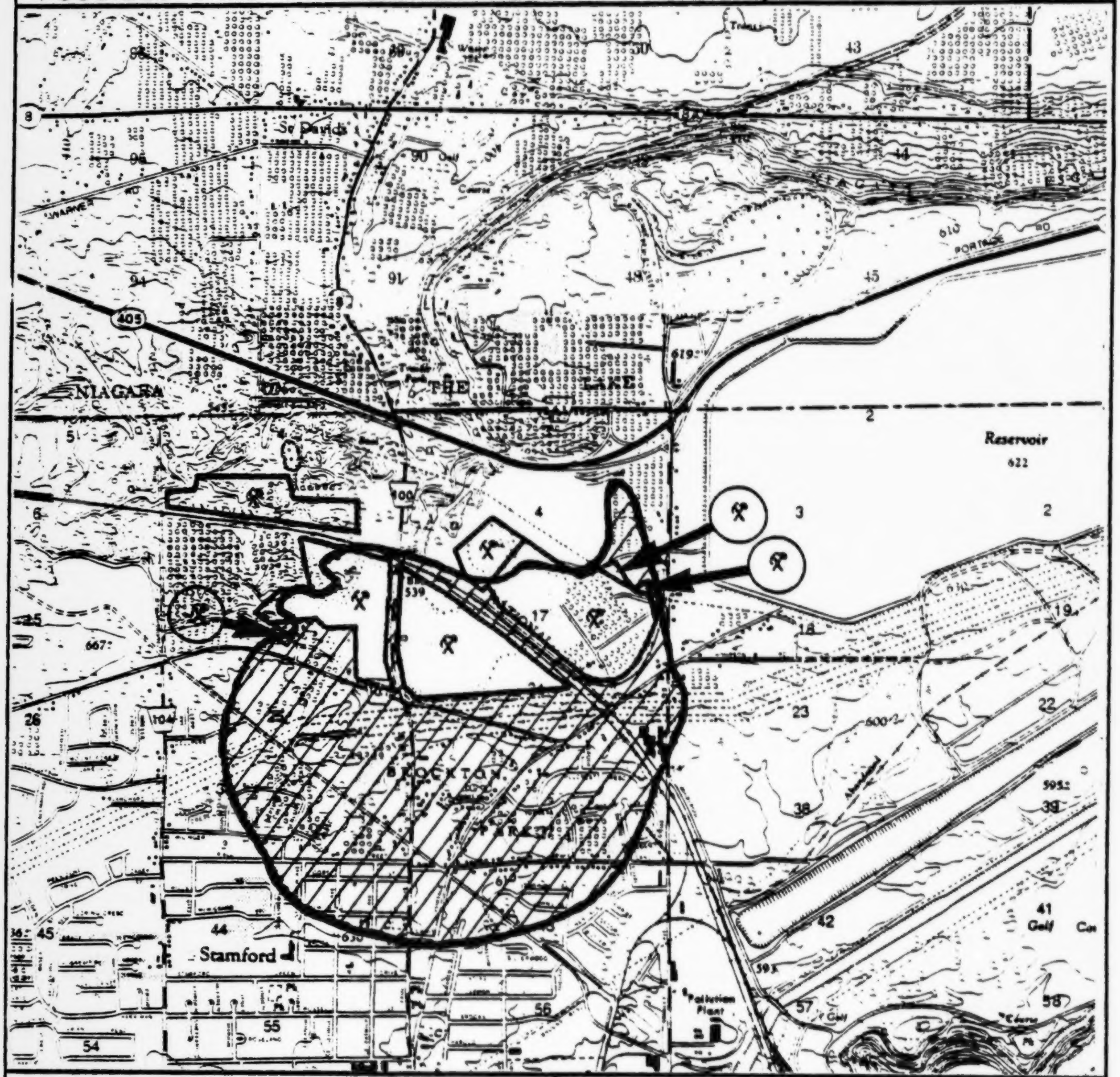
The deposits, excluding the existing development, cover about 50 acres and may contain between 400,000 and 1,500,000 tons of material. The exact amount and potential uses are unknown. However some wayside pit activity may be possible.

Constraints to development of these deposits may include houses in the area, orchards and vineyards, roads and a small creek (the One Mile Creek).

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
NIAGARA FALLS

9
SHEET NO


St Davids
8
405
NIAGARA
THE
LAKE
PORTAGE RD
Reservoir
622
100
104
BROCKTON
Stamford
Pollution Plant
Golf Course
43
44
45
48
90
91
94
2
3
4
5
6
17
18
19
22
23
25
26
38
39
41
42
54
55
56
57
58

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Legend

Licensed Sand and Gravel Pits ⚒

Possible Resource Areas ▨

SCALE 1:24,000 (1" = 2,000') (1cm : 240m)

Niagara

The Regional Municipality of Niagara
Planning and Development Department

April 1981

☐ 10 Acres Approx (4 ha approx.)

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 9

Municipality Niagara Falls

The St. Davids are is geologically complex, therefore the quantity and quality of material is unsure. The Ministry of Natural Resources has indicated that they will be conducting a detailed review of this area, (the Buried Gorge area) in the near future.

Within the possible resource area about 170 acres are licensed pits although 10 to 15 acres lie outside the resource area. In addition one 27.5 acre licensed area lies completely outside this area and may be explained by the uncertainty of the resource area boundaries in this location.

The Ministry notes that this small area is not a graunlar source and contains only fine sand and loam.

The remaining reserves within all licensed sources have been estimated at about 8 million tons.* These supplies are predominantly fine reddish sands generally used as backfill material for road and building construction. Some of these deposits may also contain some granular C (coarser) materials.** Historical extractive operations in this area seem to have depleted most of the known coarser sand and gravel.

The major constraint to further development is that much of the resource area has urban development on it.

Sources:

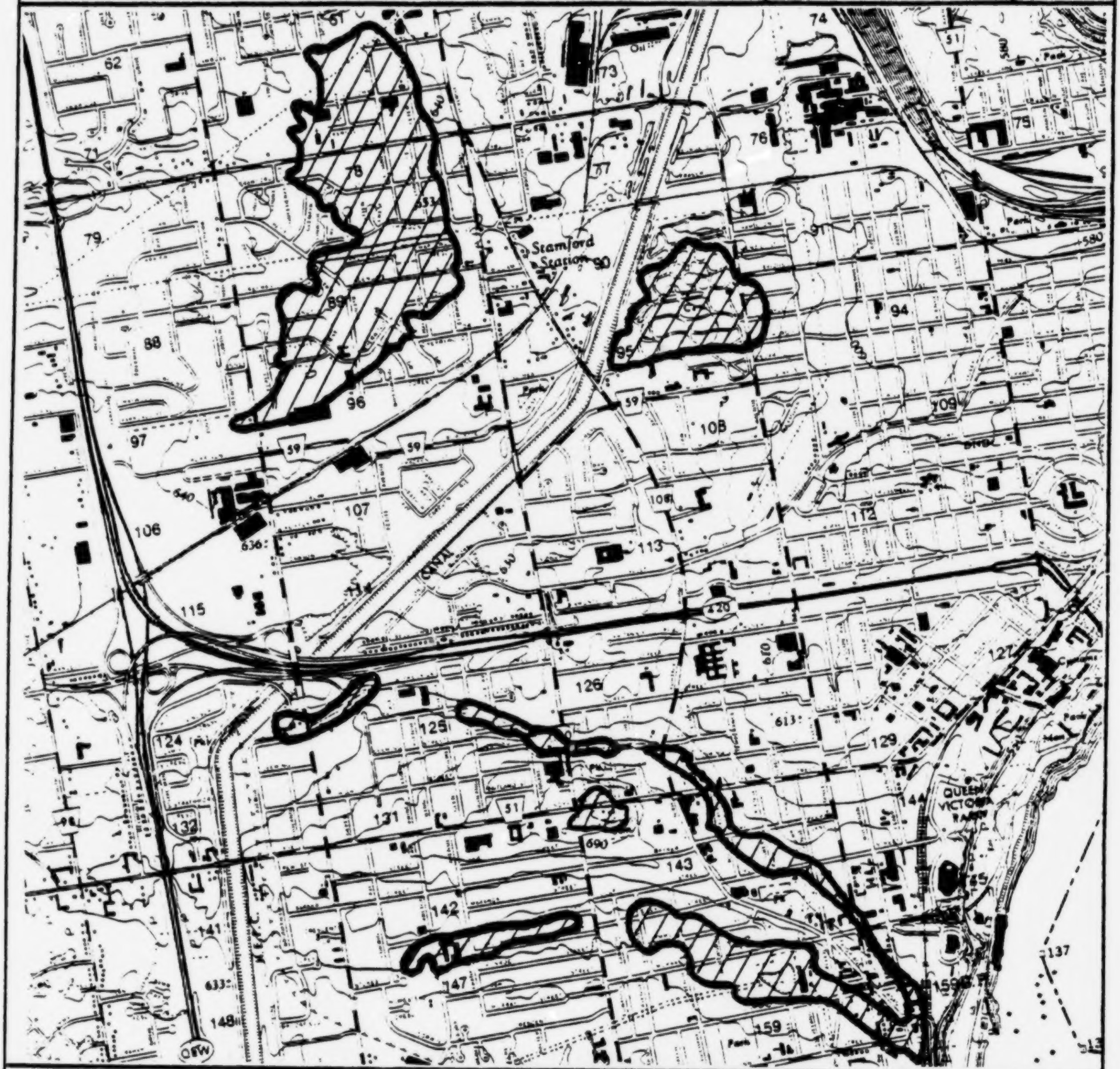
* Discussions with Ministry of Natural Resources, 1980

** Regional Municipality of Niagara Survey of Aggregate Producers, 1980.

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
NIAGARA FALLS

10
SHEET NO


Stamford Station
QUEEN VICTORIA PARK
QEW
Park
Oil
74
73
62
71
76
77
78
79
79
88
89
90
91
94
95
96
97
106
107
108
109
112
113
114
115
124
125
126
127
129
131
132
141
142
143
144
147
148
159
137
59
51
420
580
633
636
640
690
613

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

~~Possible resource area boundaries are not precise~~

Map base from Proctor & Redfern Ltd. topographic maps.

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1 : 24,000 (1" = 2,000') (1cm : 240m)

Niagara

The Regional Municipality of Niagara
Planning and Development Department

April 1981

☐ 10 Acres Approx (4 ha approx.)

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 10

Municipality Niagara Falls

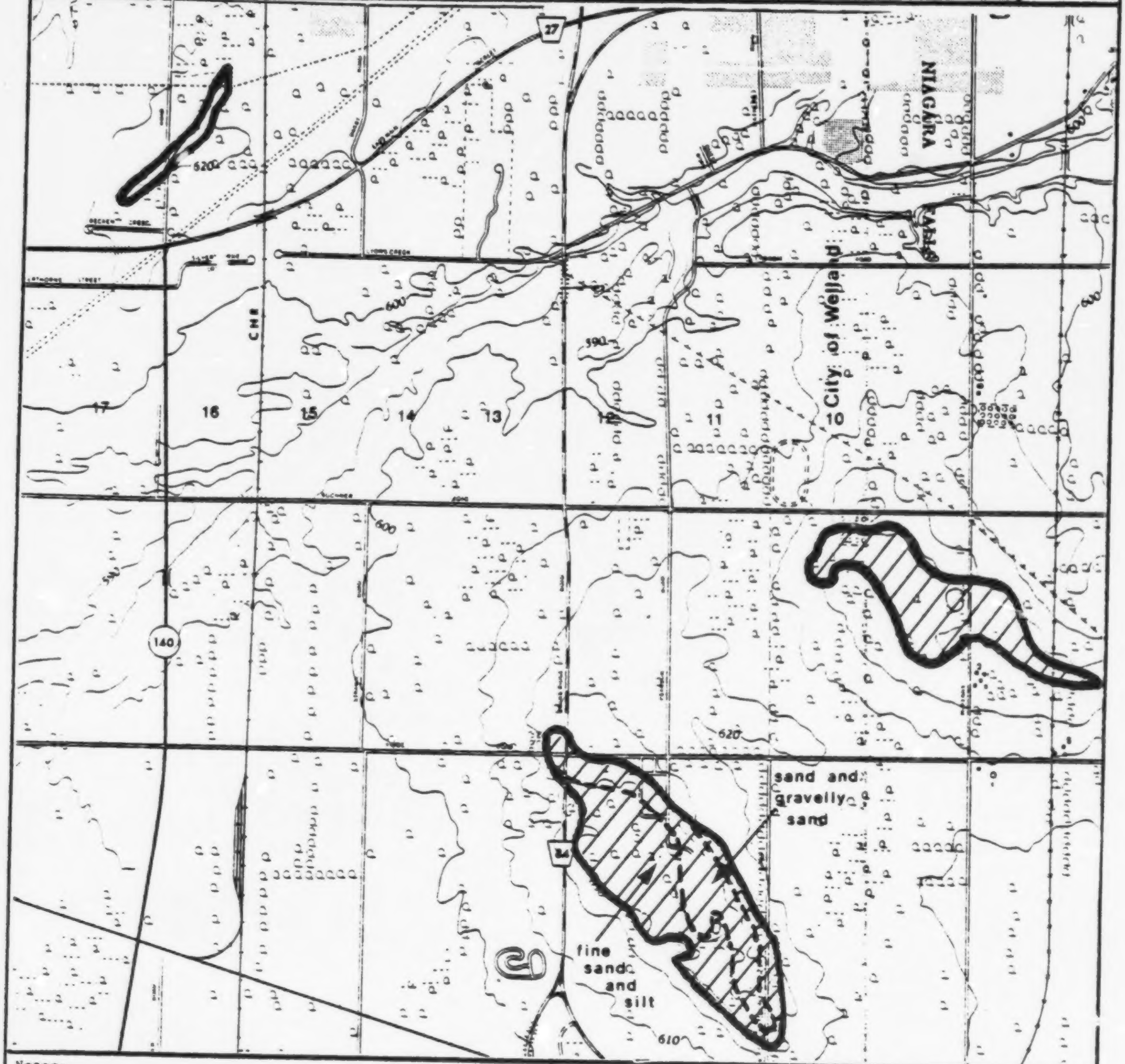
Seven scattered deposits are located in the Stamford and Lundy's Lane areas of Niagara Falls. Geologically they can be described as Lake Warren and younger pre-Iroquois deposits of gravelly sand that are greater than 6 feet in depth.

The major constraint to further extractive development is that most of the resource areas are covered by urban development including a large cemetery.

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
Welland & Niagara Falls

11
SHEET NO


27
NIAGARA FALLS
City of Welland
CNR
17
16
15
14
13
12
11
10
140
84
620
600
590
610
sand and gravelly sand
fine sand and silt

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1:24,000 (1" = 2,000') (1cm = 240m)

April 1981

☐ 10 Acres Approx (4 ha approx.)

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 11

Municipality Welland & Niagara Falls

The Ministry of Natural Resources completed an office assessment of Welland's mineral aggregate resources in August, 1980. In total only three deposits had been identified and mapped within the City's limits and are generally situated in the southeast portion of Welland. However, the largest part of one of the deposits which straddles the eastern municipal boundary, lies with the City of Niagara Falls. This deposit has not been assessed in full by the Ministry.

The three deposits are the sites of former proglacial lake beaches which occur on morraine ridges composed of fine-grained till protruding through the thick blanket of proglacial lake clays that underlie most of the City. Generally, these features are narrow and linear. In the past they have been subject to a great deal of extractive activity by small wayside pits.

The deposit lying in the upper left hand corner of Sheet No. 11 may contain about 82,000 tons of sand and gravel with some deleterious shale fragments present. Constraints to development of this deposit may include roads, houses, and a hydro transmission line.

The deposit which is delimited by a dashed boundary line at the bottom of sheet No. 11, ranges from 5 to 10 feet in depth and may contain about 500,000 tons of sand with less than 35% gravel present. More sand and silt material for backfill purposes may be available in the remainder of the deposit located outside the area shown by a dashed line. Deleterious shale and siltstone fragments are also present. Constraints to development of this deposit may include roads, houses and a cemetery.

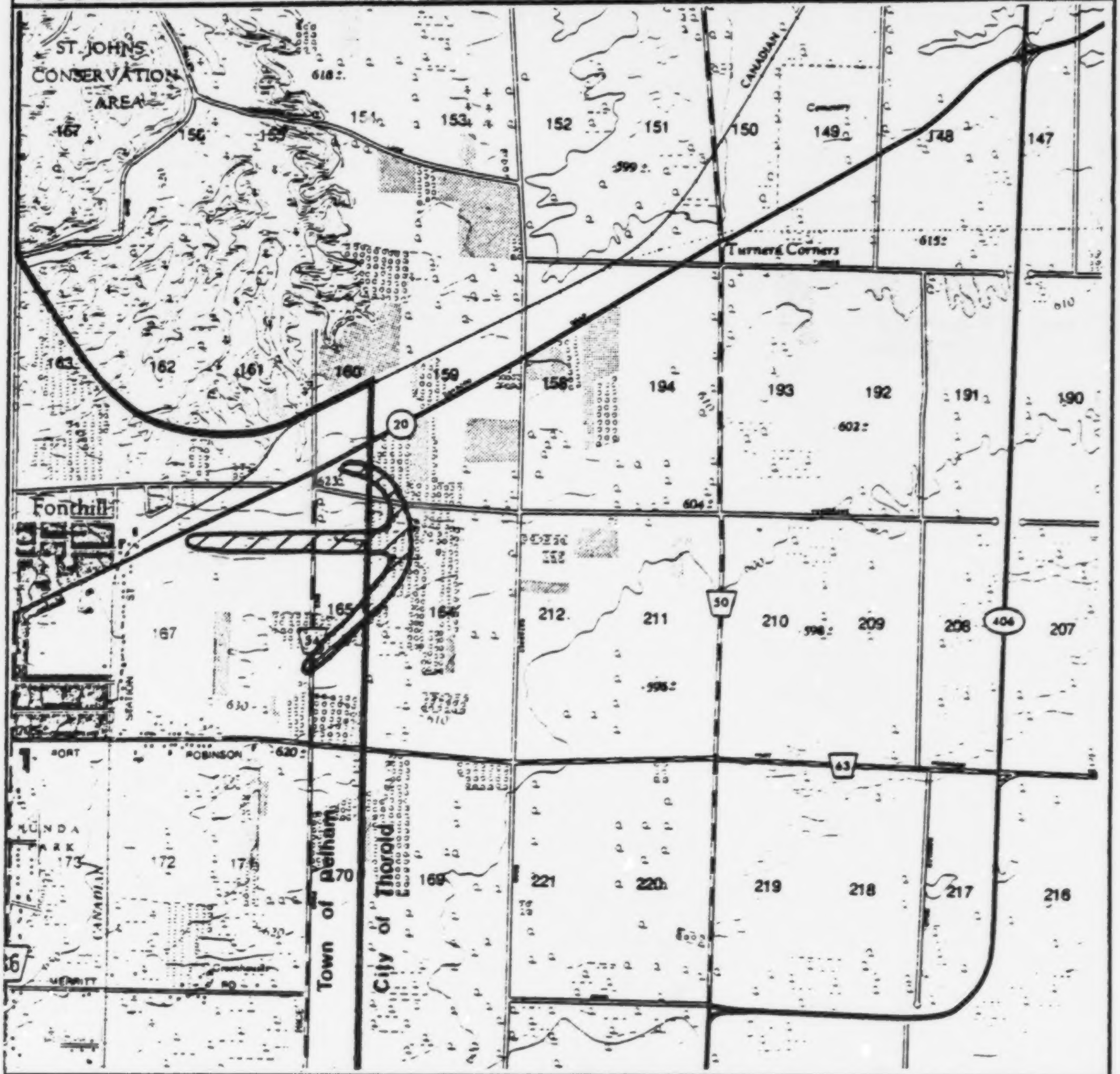
The western tip of the deposit found on the right hand side of sheet No. 11 has an average thickness of less than 5 feet and may contain about 45,000 tons of sand and gravel. This material contains more than 35% gravel and some deleterious shale fragments are present. The remainder of this deposit located in Niagara Falls is assumed to have a similar quality material and depth. Excluding the existing development, this part of the deposit covers about 40 acres and may contain between 450,000 and 550,000 tons of material. The exact amount and potential uses are unknown. Constraints to development of the whole deposit include houses, roads and a railway line.

It is the opinion of the Ministry of Natural Resources that the probability of obtaining crushable aggregate is low since the beach material was derived by wave-washing of the fine-grained till. Some potential for wayside pit activity may be available.

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
Pelham & Thorold

12
SHEET NO


ST. JOHNS CONSERVATION AREA
167
156
155
154
153
152
151
150
149
148
147
Cemetery
618
599
615
Turners Corners
163
162
161
160
159
158
194
193
192
191
190
602
610
20
Fonthill
604
165
164
167
212
211
210
209
208
207
598
50
406
595
630
610
620
PORT ROBINSON
63
173
172
171
170
169
221
220
219
218
217
216
CANADIAN
MERRITT RD
Town of Pelham
City of Thorold

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara
The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1 : 24,000 (1" = 2,000') (1cm = 240m)

April 1981

☐ 10 Acres Approx (4 ha approx.)

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 12

Municipality Pelham-Thorold

A small anchor-shaped deposit lies a short distance east of Fonthill crossing the Pelham-Thorold boundary. Geologically this is a relatively young pre-Iroquois beach and bar deposit of stratified sand and gravel up to about 7 feet in depth. This deposit lies on the lower flank of the Fonthill delta.

This deposit, excluding the existing development, covers approximately 15 acres and may contain between 250,000 and 350,000 tons of material. The exact amount and potential uses are unknown.

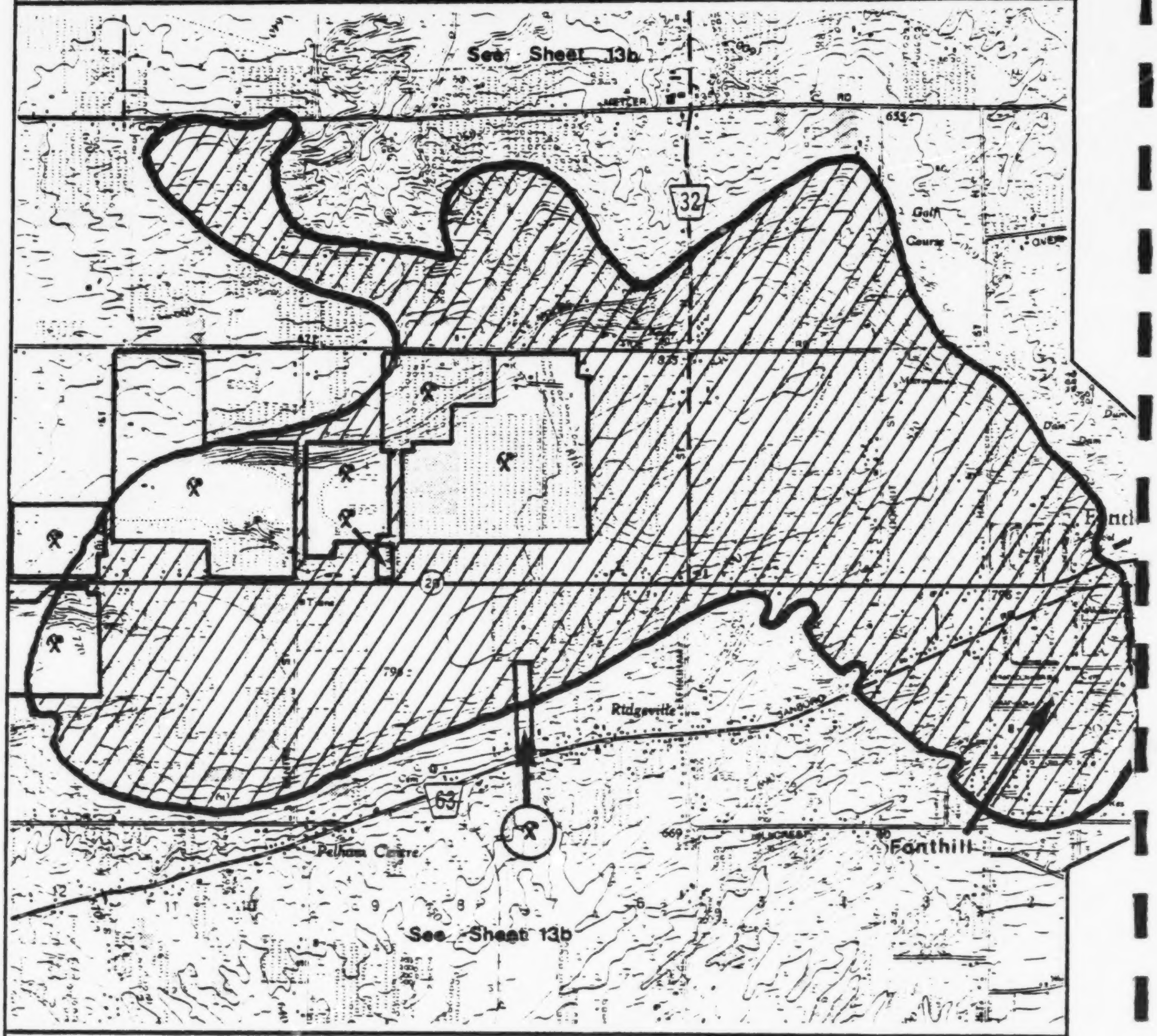
Constraints to development of this deposit may include houses in the area, roads, commercial establishments and orchards.

NIAGARA SAND AND GRAVEL STUDY

POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
PELHAM

13a
SHEET NO


See Sheet 13b
32
Golf Course
Ridgeville
63
Pelham Centre
Fonthill
Fonthill
See Sheet 13b

Notes:

(1) Possible resource areas derived from inventory maps of the Ministry of Natural Resources, 1980.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1:24,000 (1" = 2,000') (1cm = 240m)

April 1981

☐ 10 Acres Approx (4 ha approx.)

N

Niagara

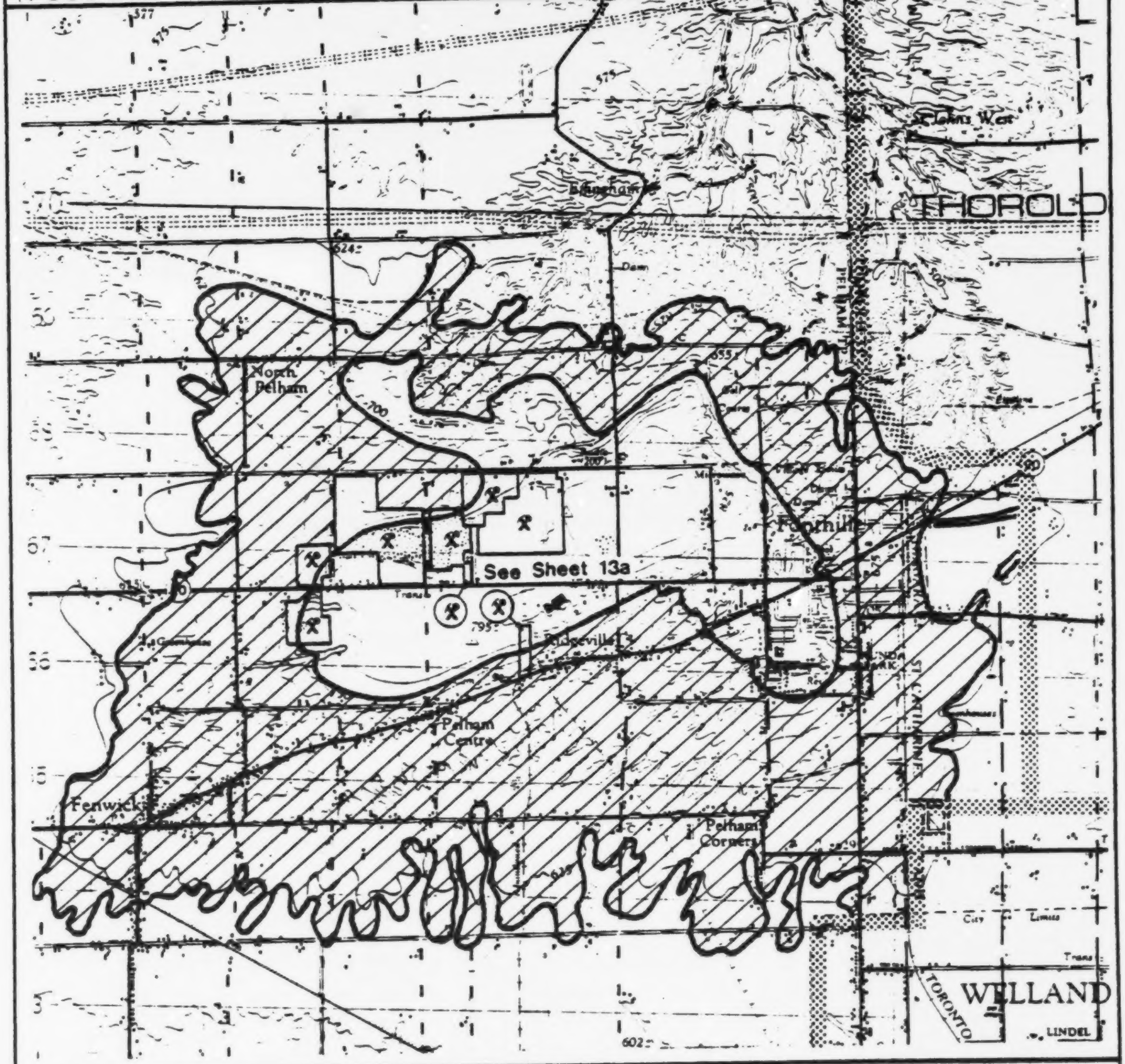
The Regional Municipality of Niagara
Planning and Development Department

NIAGARA SAND AND GRAVEL STUDY

POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
PELHAM

13b
SHEET NO


577
575
St Johns West
Effingham
THOROLD
624
Dam
North Pelham
700
655
Fonthill
See Sheet 13a
Trans
795
Ridgeville
Pelham Centre
Fenwick
Pelham Corners
City Limits
WELLAND
TORONTO
LINDEL
602

NOTES:

1. Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources, 1980.
2. Licensed areas derived from site plans provided by the Ministry of Natural Resources.
3. Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise.

Map base from Department of Energy, Mines and Resources, 1973.

Legend

Licensed Sand and Gravel Pits ⚒

Possible Resource Areas ▨

Scale: 1:50,000

Mile 1 — 0 — 1 Mile

Metres 1000 — 0 — 1 Kilometre

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Planning and Development Department

April 1981

☐ 20 Acres Appr. (8 ha approx.)

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet Nos. 13a and 13b

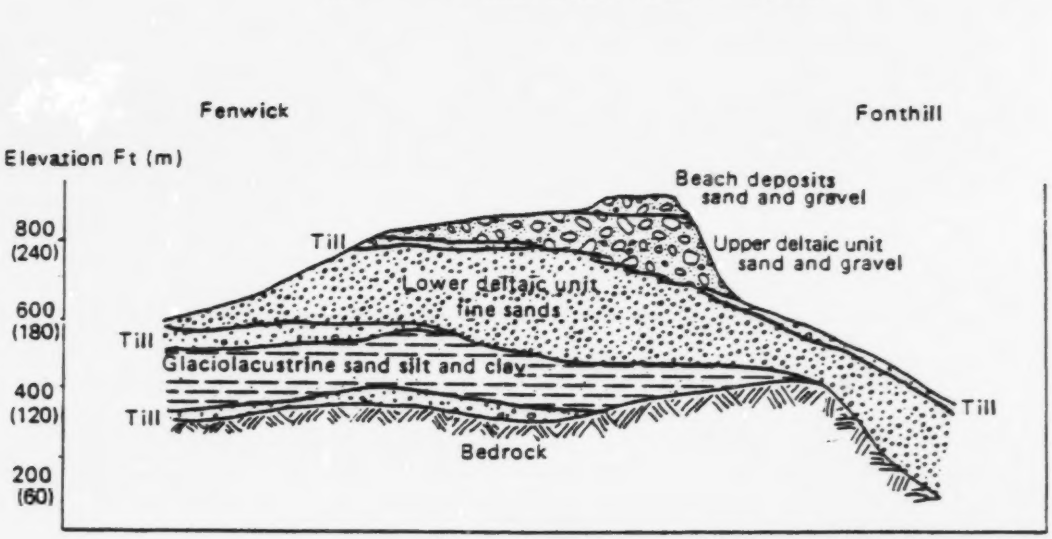
Municipality Pelham

The Fonthill Kame is the Niagara Region's largest land-based deposit of sand and gravel. This feature which was created during the last glacial age, is an ice-contact glaciolacustrine delta complex which is located at the head of the Twelve Mile Creek re-entrant valley in the Niagara Escarpment.

As illustrated in the figure below, several deltaic layers form the internal structure of the Fonthill Kame which in places is more than 100 feet thick. It is the upper, coarser deltaic unit and beach deposits which contain the better commercial deposits of extractable sand and gravel aggregate.

Generalized Internal Structure of the Fonthill Kame (southwest ridge)

SW —— Direction of glacier retreat ——> NE


Fenwick
Fonthill
Elevation Ft (m)
800 (240)
600 (180)
400 (120)
200 (60)
Beach deposits sand and gravel
Till
Upper deltaic unit sand and gravel
Lower deltaic unit fine sands
Till
Glaciolacustrine sand silt and clay
Till
Till
Bedrock

Horizontal distances not to scale

Source: Ontario Geological Survey, Aggregate Resource Inventory of the Town of Pelham, Regional Municipality of Niagara-Southern Ontario, Toronto, 1980 .

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet Nos. 13a and 13b
(Page 2)
Municipality Pelham

In the past several pits excavated sand and gravel from this feature but were later abandoned. Today three licensed operations occupy 462.5 acres on the Kame. Two operations extract sand and gravel from the northwestern flank of the Kame but one small producer is excavating in the southern portion near Ridgeville. A wide range of products come from this deposit. They include granular A, pit run, concrete sand, asphalt sand, winter sand, mortar sand, sand cushion and sand fill. Several problems face the producers however in terms of the quality of the extracted materials. These include low and variable stone content, a high percentage of fine sand, presence of reddish clays and silts and frequent pockets of highly cemented materials. These factors combine to make processing of the material necessary and thus relatively costly.

In 1980 the Ministry of Natural Resources released an inventory and evaluation of aggregate resources for the Town of Pelham* which represents the most up-to-date information available. The Ministry has noted that some additional drilling and sampling may take place in the summer of 1981. According to their calculations of selected sand and gravel resources of "primary" significance shown on Map 13a, available resources of 95 million tons are present.

Although this deposit has been identified to contain greater than 35% gravel throughout, variations in thickness, depths and amounts of granular materials appear to occur.

The areas west of Fonthill and east of the existing licensed pits has the thickest deposits (60 feet) of coarse gravel. The percentage of coarse aggregate ranges as high as 50%. Several beach ridges (15 to 30 feet deep), consisting of well-sorted and stratified sand and gravel, are present. These are underlain by 30 to 50 feet of fine to coarse-grained, cross-bedded, gravelly sand and gravel.

---

* Ontario Geological Survey, Aggregate Resources Inventory of the Town of Pelham, Regional Municipality of Niagara, Ontario Geological Survey, Aggregate Resources Inventory Paper 4, 33p., 6 tables, 3 maps, scale 1:50,000, 1980.

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No s. 13a and 13b
(Page 3)
Municipality Pelham.

The area south of the existing licensed pits and Fonthill lies in the upper deltaic unit of sand and gravel but the coarser materials are not as thick as in the previously noted location. The thicker coarse gravels near the surface have undergone extractive activity in the past especially along the northerly ice-contact slope of the Kame. The Ministry of Natural Resources has indicated that coarser deposits may be available at greater depths in some locations. Discussions held with one producer in the area lends some support to this fact noting that coarse deposits are present to the west of E.L. Crossley High School.

The northerly area which runs west from the main deposit is the thinnest section of the deposit (20 feet) containing an upper deltaic unit of sand and gravel underlain by a lower unit of deltaic fine-grained sand.

Constraints to development of this deposit may include urban and suburban development, orchards, vineyards and environmental considerations.

Figure 13b identifies the extent of the deposit which lies at the extremities and beyond the Fonthill Kame feature. These have been identified by the Ministry as selected resource areas of "secondary" significance. The deposit consists of lower deltaic sand and silts and associated fine-grained, nearshore lacustrine sediments. Three currently licensed pit operations are partially located within this area and in the past several small abandoned pits south of Canboro Road also extracted some material.

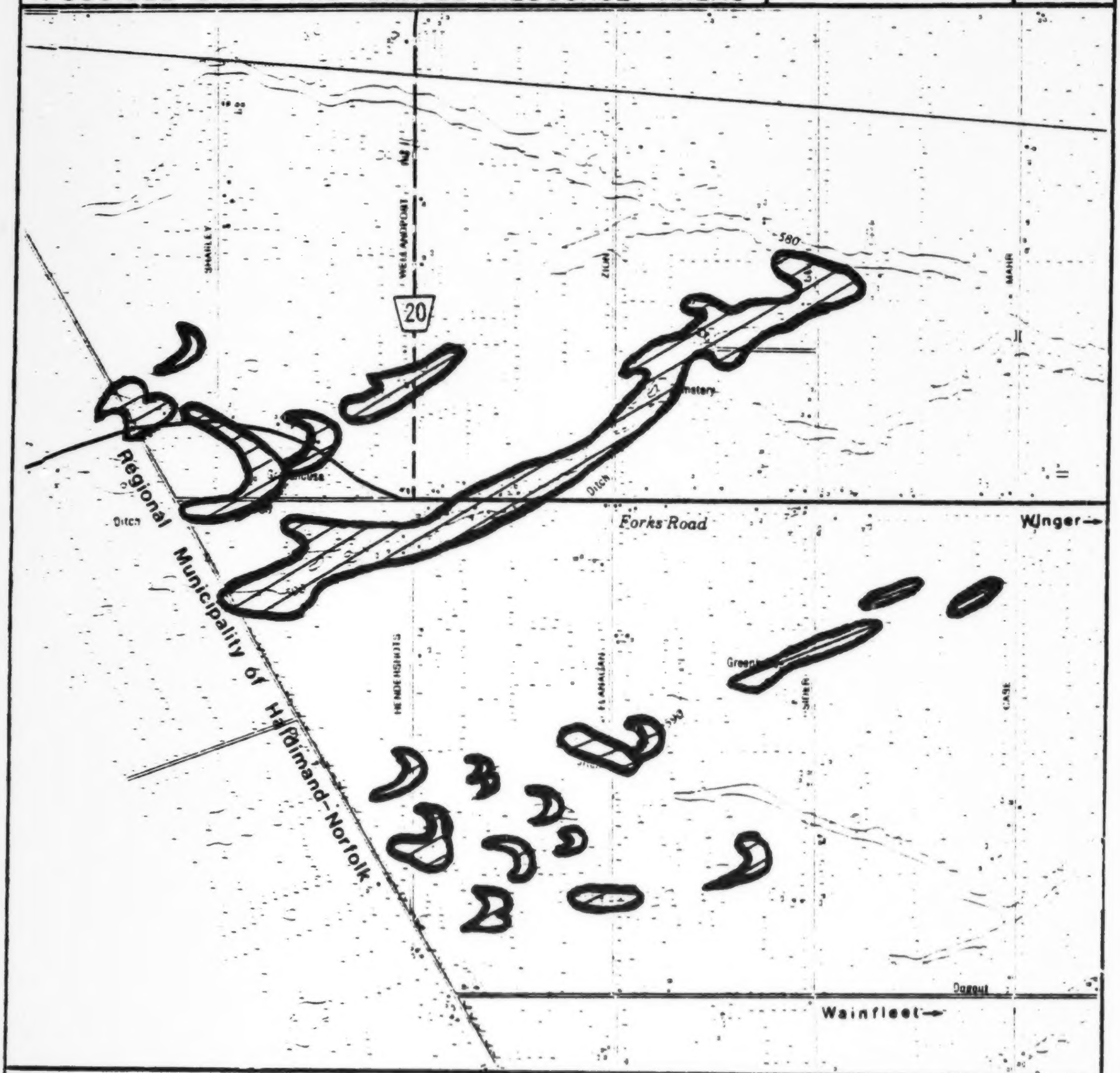
The Ministry of Natural Resources indicates that these deposits are probably of little commercial value because of the absence of crushable material. Estimated total reserves and potential uses of this deposit have not been determined.

Constraints to development of this deposit may include urban and suburban development, orchards, and recreational areas.

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
WAINFLEET

14
SHEET NO


20
WELLANDPORT
SHARLEY
ZION
MAHR
580
Cemetery
Ditch
Forks Road
Winger→
Regional Municipality of Haldimand-Norfolk
Greens
HENDERSHOTS
FLANAGAN
SIDER
CASE
Dogout
Wainfleet→

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

~~Possible resource area boundaries are not precise~~

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits ⚒

Possible Resource Areas ▨

SCALE 1 : 24,000 (1" : 2,000') (1cm : 240m)

April 1981

☐ 10 Acres Approx (4 ha approx.)

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 14

Municipality Wainfleet

A field of parabolic and longitudinal inland sand dunes lie west of the village of Wainfleet. These dunes, which were molded by the prevailing westerly winds, consist of uniform fine to very fine sand materials and reach a maximum height of about 25 feet. Generally they are finer-grained and more loamy than the dunes which stretch along the Lake Erie shoreline. The deposits rest on shallow-water or deltaic sediments from which the dune sand may have been derived.

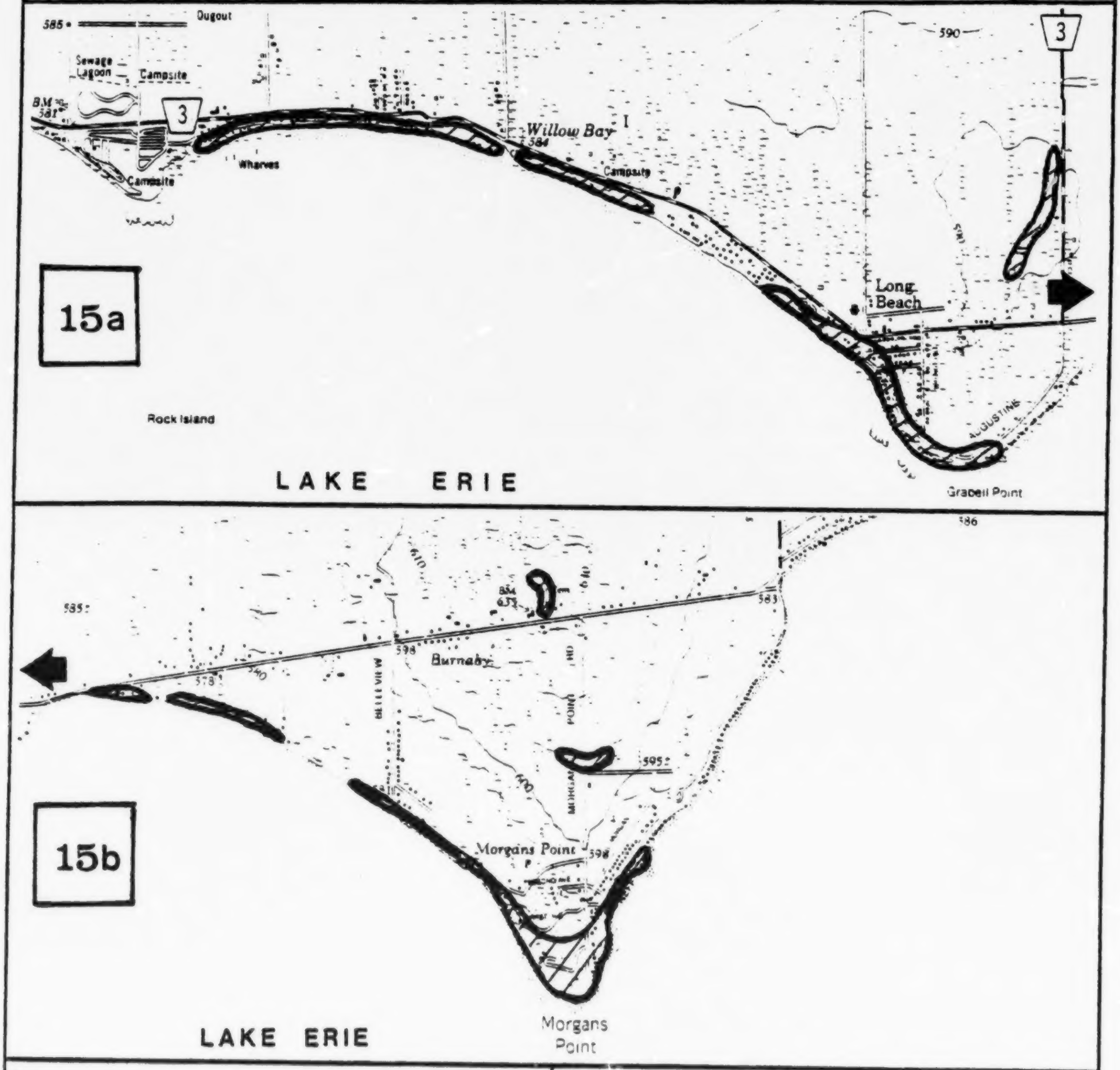
Some sand extraction appears to have occurred in the past. The amount of material present in all of these deposits however is difficult to estimate because of the variable thicknesses which may be present. The Ministry of Natural Resources has expressed an interest in these deposits and may be conducting in depth analyses, including drilling, in 1981. Potential uses of this type of material may include sand for filtration, fill, cushion and asphalt-making purposes.

Constraints to development of these deposits may include houses in the area, roads, cemeteries and agricultural activities (e.g. a grain drying operation, greenhouse).

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
WAINFLEET

15
SHEET NO


585
Dugout
Sewage Lagoon
Campsite
BM 581
3
Wharves
Campsite
Willow Bay
584
Campsite
590
3
Long Beach
15a
Augustine
Rock Island
LAKE ERIE
Grabell Point
586
585
583
BM 635
610
640
598
Burnaby
578
Bellevue
Point Rd
595
15b
Morgans Point
598
LAKE ERIE
Morgans Point

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1 : 24,000 (1" : 2,000') (1cm : 240m)

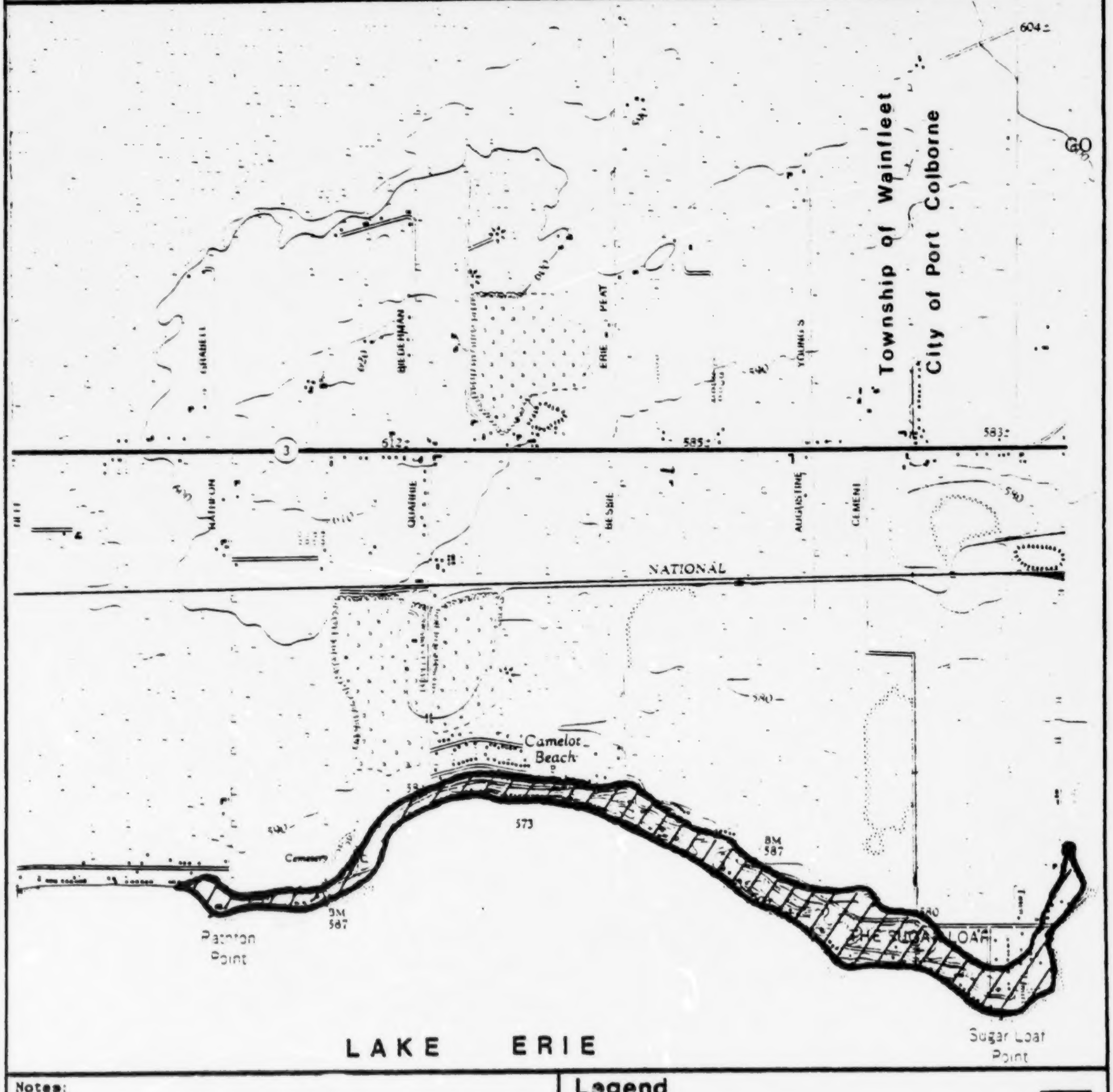
April 1981

☐ 10 Acres Approx (4 ha approx.)

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
Port Colborne &
Wainfleet

16
SHEET NO



604
GO
Township of Wainfleet
City of Port Colborne
GRABELL
BIEDERMAN
ERIE
PEAT
YOUNGS
512
3
585
583
610
QUARRIE
BESSIE
AUGUSTINE
CEMENT
590
NATIONAL
580
Camelot Beach
573
BM 587
Cemetery
BM 587
Rathfon Point
THE SUGAR LOAF
Sugar Loaf Point
LAKE ERIE

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1 : 24,000 (1" : 2,000') (1cm : 240m)

FEET 1000 0 1000 2000 3000 4000

METRES 200 0 500 1000

April 1981

☐ 10 Acres Approx (4 ha approx.)

N

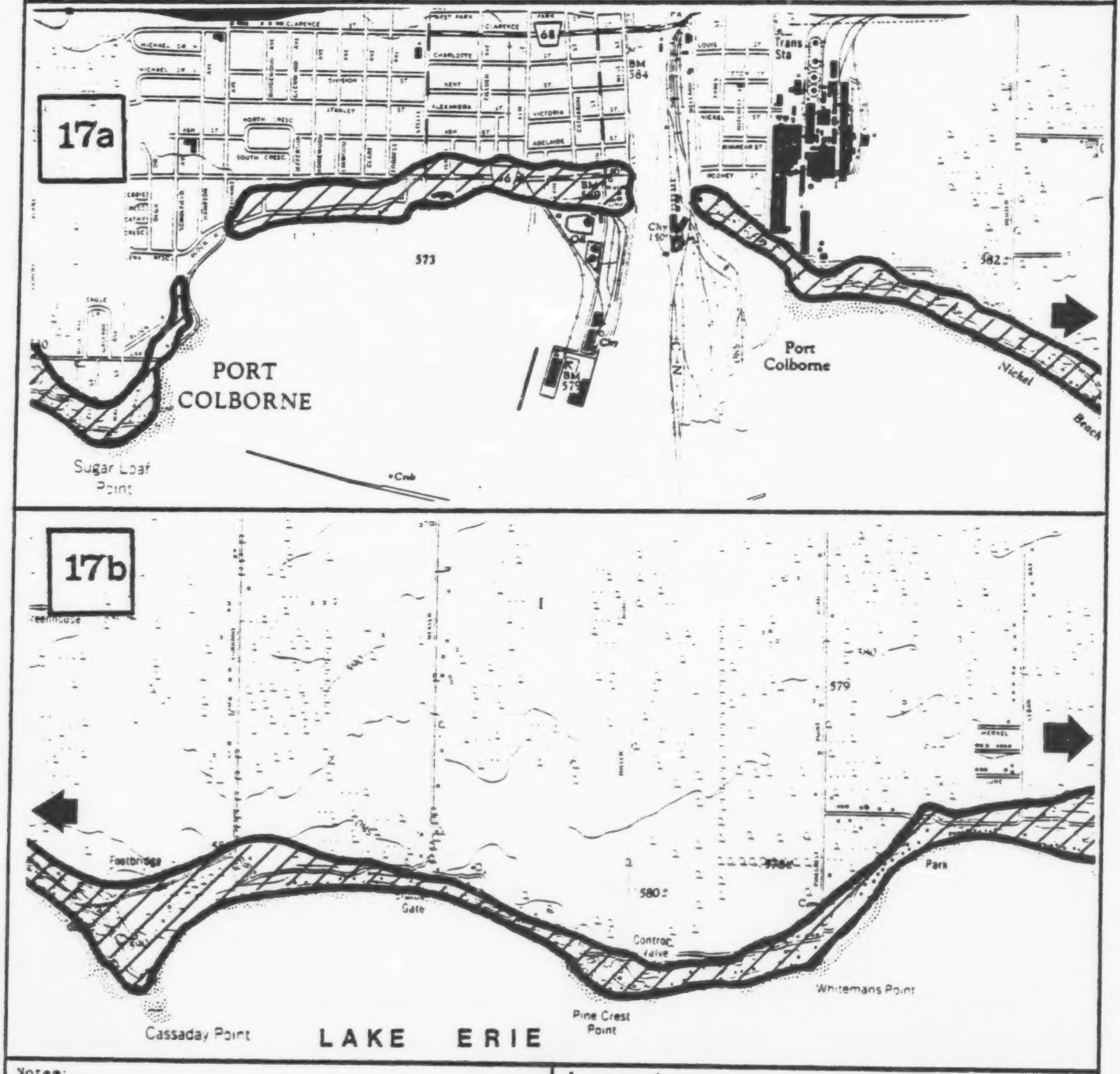
Niagara

The Regional Municipality of Niagara
Planning and Development Department

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
PORT COLBORNE

17
SHEET NO


17a
PORT COLBORNE
Port Colborne
Sugar Loaf Point
Nickel Beach
Trans Sta
BM 584
BM 579
573
582
68
17b
Footbridge
Gate
Control Valve
Park
Cassaday Point
Pine Crest Point
Whitemans Point
LAKE ERIE
579
580

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits ⚒

Possible Resource Areas ▨

SCALE 1:24,000 (1" = 2,000') (1cm = 240m)

April 1981

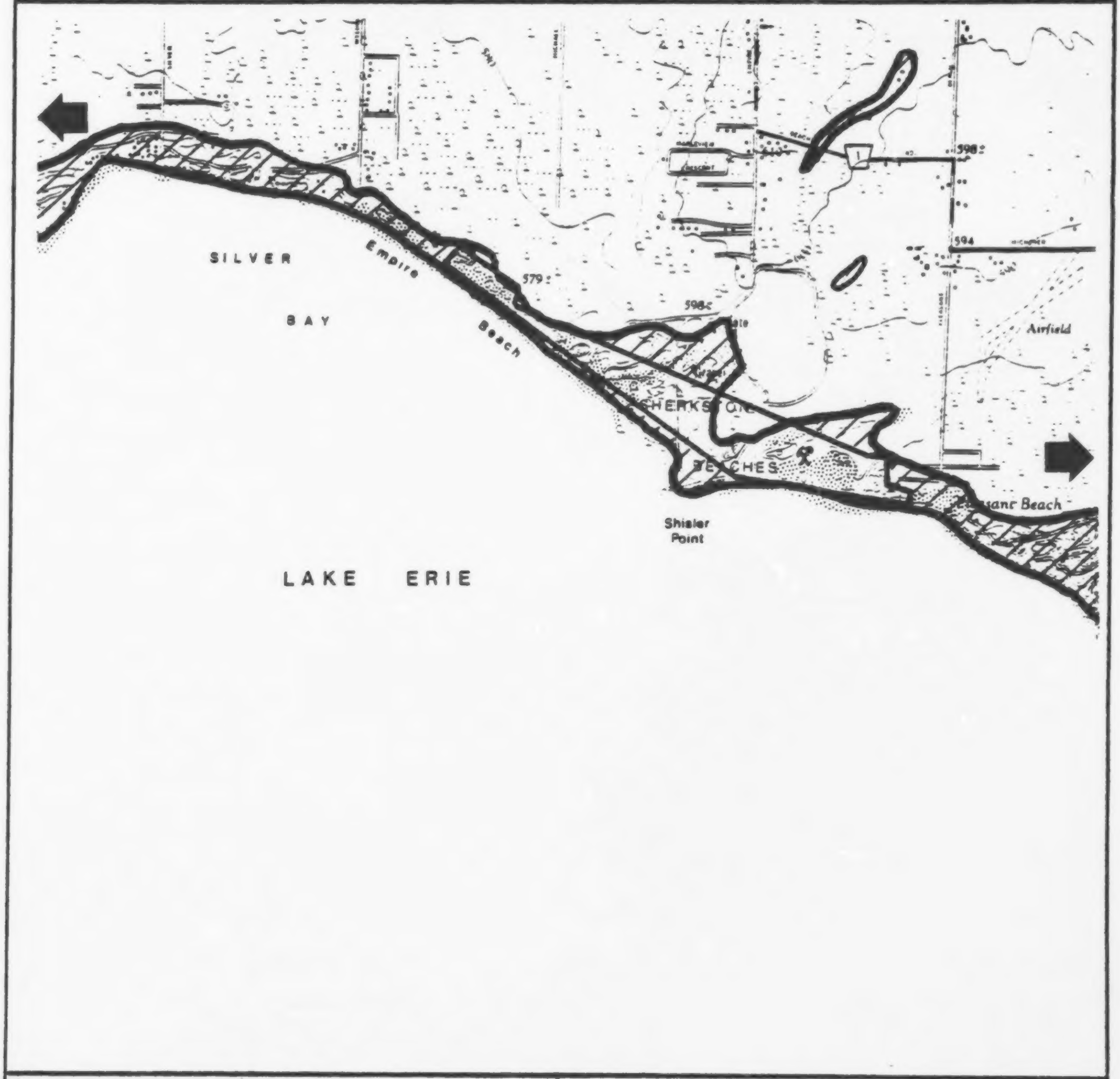
☐ 10 Acres Approx (4 ha approx.)

NIAGARA SAND AND GRAVEL STUDY

POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
PORT COLBORNE

18
SHEET NO


SILVER
BAY
Empire
Beach
579
598
594
Airfield
SHERKSTON
BEACHES
Shisler
Point
...sant Beach
LAKE ERIE

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Legend

Licensed Sand and Gravel Pits ⚒

Possible Resource Areas ▨

SCALE 1:24,000 (1" = 2,000') (1cm = 240m)

Niagara

The Regional Municipality of Niagara
Planning and Development Department

April 1981

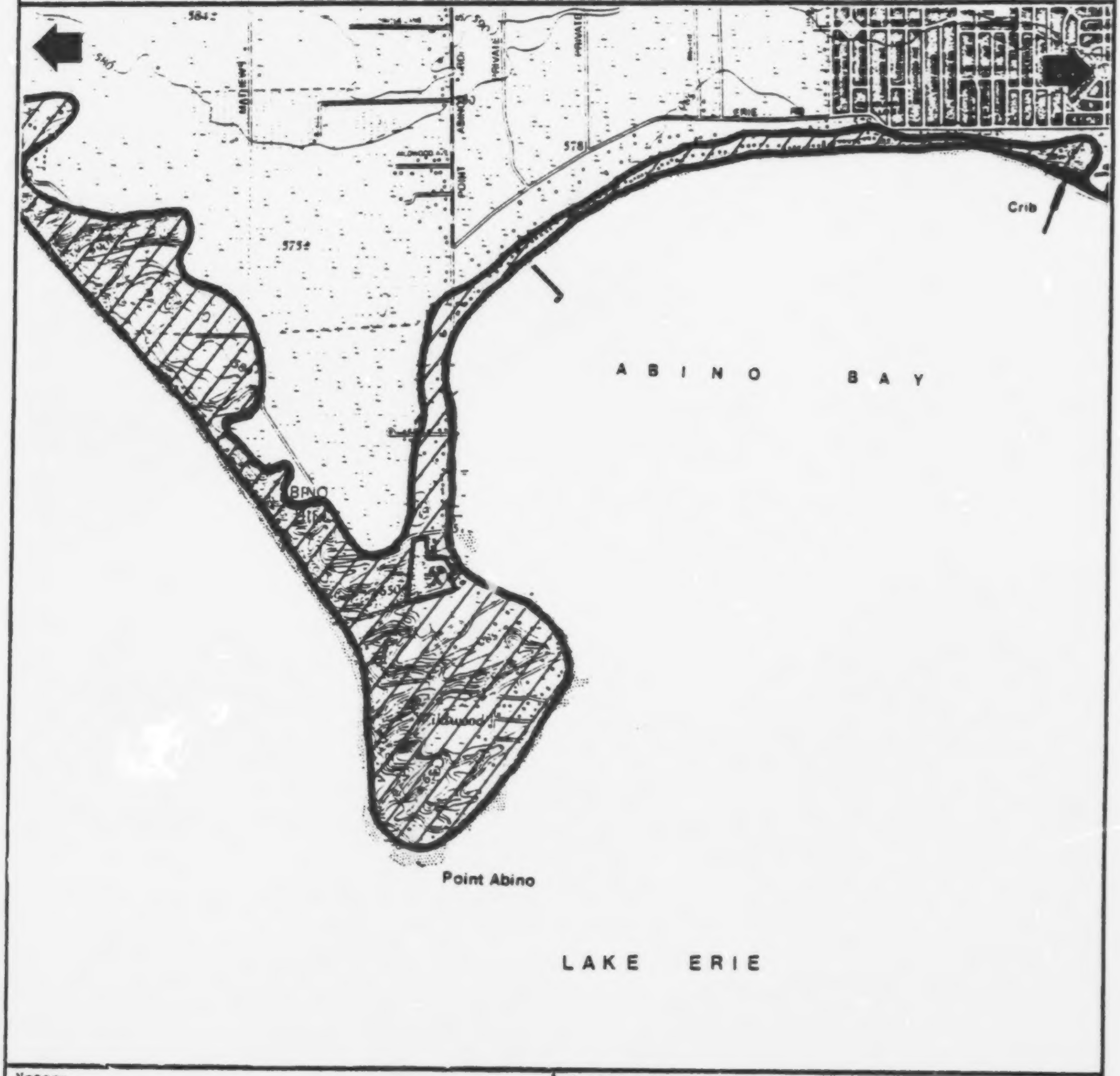
☐ 10 Acres Approx (4 ha approx.)

N

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
FORT ERIE

19
SHEET NO



Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits ⚒

Possible Resource Areas ▨

SCALE 1:24,000 (1" = 2,000') (1cm = 240m)

April 1981

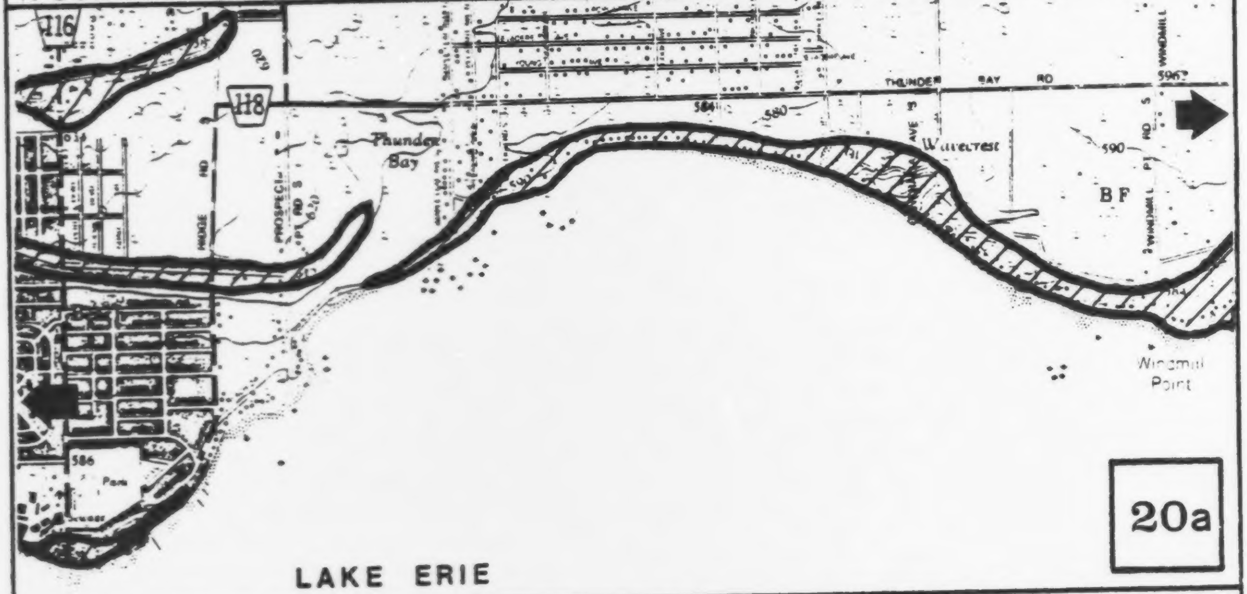
☐ 10 Acres Approx
(4 ha approx.)

NIAGARA SAND AND GRAVEL STUDY

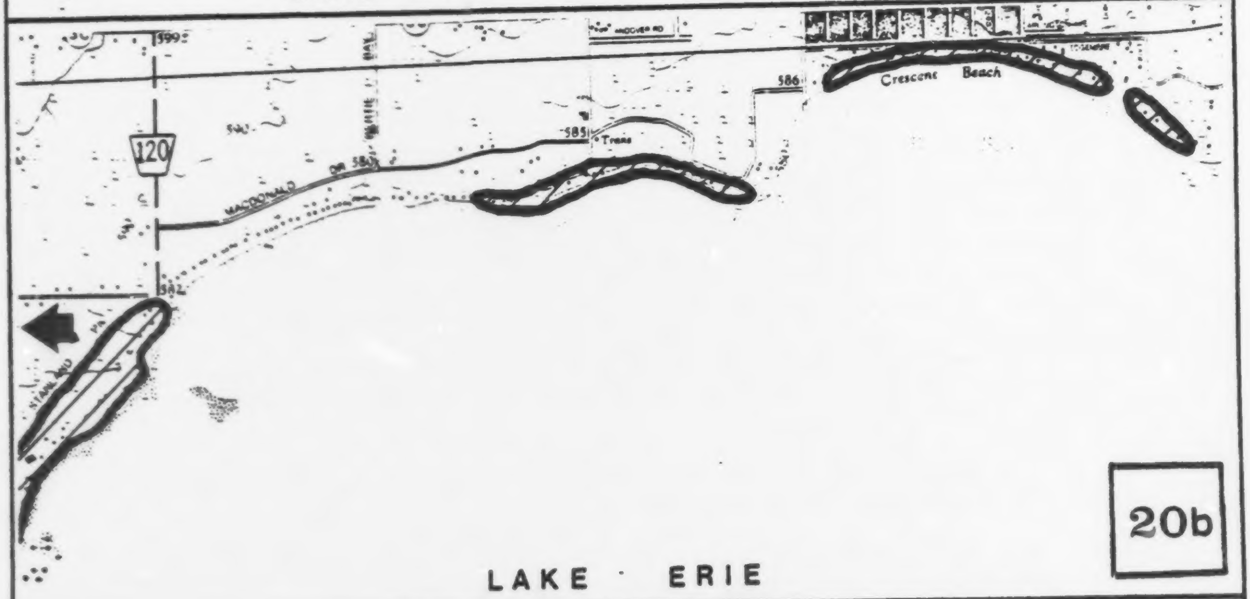
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
FORT ERIE

20
SHEET NO


116
118
Thunder Bay
THUNDER BAY RD
584
580
590
Wavecrest
BF
Windmill Point
586
Park
LAKE ERIE

20a


120
MACDONALD DR
580
585
586
Crescent Beach
LAKE ERIE

20b

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1:24,000 (1" : 2,000') (1cm : 240m)

April 1981 ☐ 10 Acres Approx (4 ha approx.)

Niagara
The Regional Municipality of Niagara
Planning and Development Department

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet Nos. 15 to 20

Municipality Wainfleet, Port
Colborne, Fort Erie.

The sand deposits found along the Lake Erie shoreline appear as narrow strips of longitudinal sand dunes which extend behind the Lake Erie beach. These deposits stretch from the area west of Grabell Point in Wainfleet to the Crescent Beach area in Fort Erie. They have been formed by the dual processes of eastward moving, long shore transport of sand by Lake Erie waters and then subsequently by westerly winds which have moved and molded the newly-deposited beach sands. Although the height of many of the dunes varies from place to place, those located in the Port Colborne and Fort Erie areas tend to be higher and better developed than those in the western shoreline zone of Wainfleet. Dune sand material is uniformly fine to medium-grained and is rich in quartz minerals.

Some sand extraction has occurred in scattered locations along the dune deposits. In the Sherkston - Point Abino areas about 127 acres are currently licensed and the material is being used for a limited range of specialized uses which include blending for asphalt construction, backfilling, metal casting and filtering. In addition, at least two other small pits located in the Wainfleet and Port Colborne beach areas have been used in the past by a local producer mainly for blending with coarser, fine aggregate in asphalt making.

The amount of materials present in the dune deposits is extremely difficult to estimate because of the variable thickness which may be present.

The Ministry of Natural Resources has indicated that more detailed studies may be done in the future.

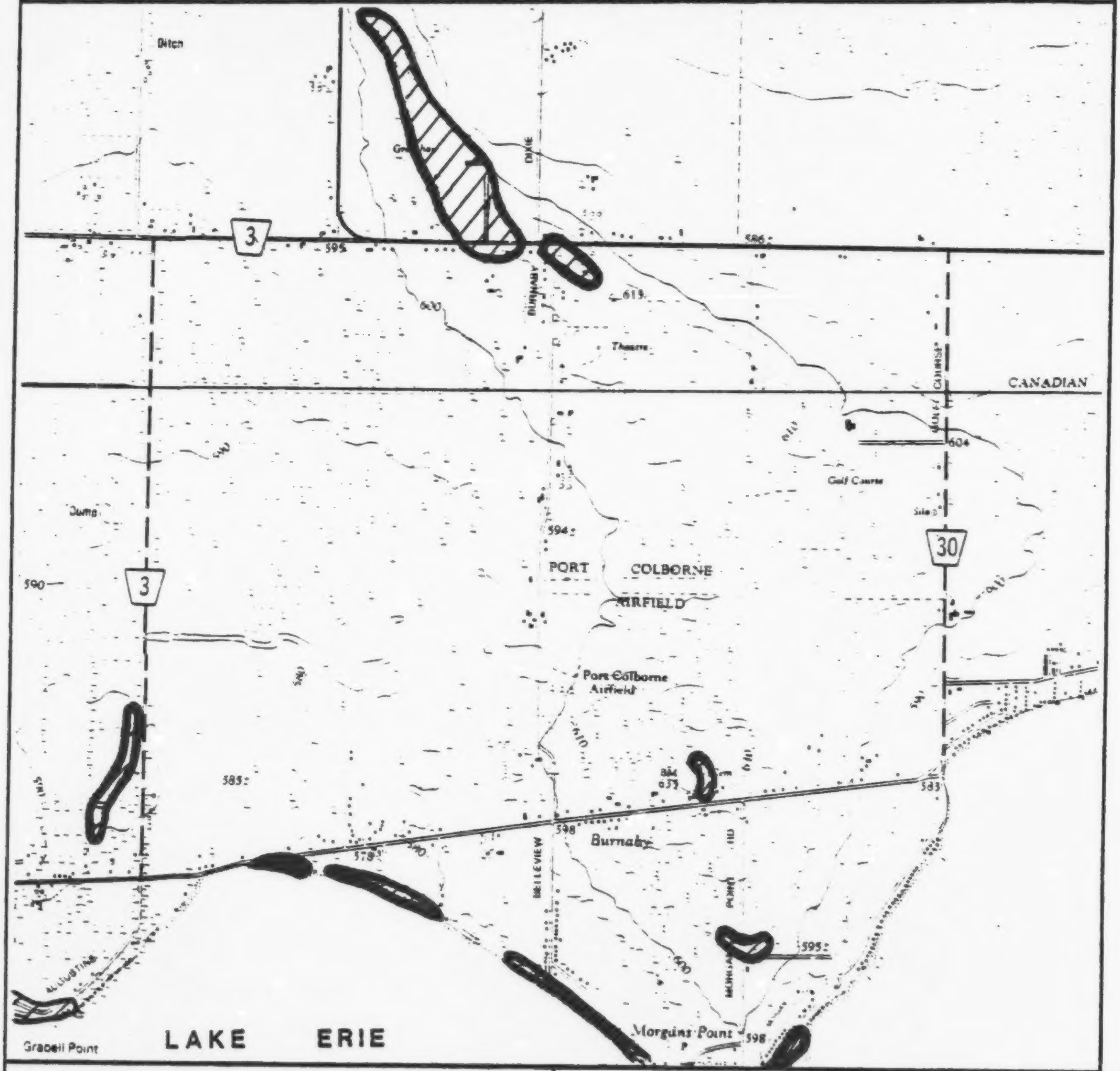
One of the major constraints to development of these deposits is the existing development which often is continuous and lines the Lake Erie shoreline. Examples of such development may include seasonal cottages and permanent homes, roads, cemeteries, railway lines, industrial uses, trailer parks, and numerous public and private recreational areas.

Although some dune areas along the shoreline may be free of development, environmental considerations may limit extraction. The forested dunes in the Sherkston and Point Abino areas for example have been considered by many to be unique but fragile features of Ontario. Dunes are sensitive to wind erosion once their protective vegetation is removed.

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
WAINFLEET

21
SHEET NO


Ditch
3
595
586
DIXIE
BURNABY
600
615
Theatre
CANADIAN
604
Golf Course
594
PORT COLBORNE
AIRFIELD
30
3
590
Dump
Port Colborne
Airfield
585
583
598
Burnaby
BELLEVIEW
POINT
595
600
AUGUSTINE
Morgans Point
598
LAKE ERIE
Gracell Point

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1 : 24,000 (1" = 2,000') (1cm : 240m)

FEET 1000 0 1000 2000 3000 4000
METRES 300 0 500 1000

April 1981

☐ 10 Acres Approx (4 ha approx.)

N

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 21

Municipality Wainfleet

Five inland deposits are located in the area generally surrounding the Port Colborne airfield. Geologically, they are glaciolacustrine beach/off-shore bar deposits of sand and gravel about 5 feet in depth. The southern-most deposit may have had some extractive activity in the past.

The deposits, excluding the existing development, cover about 45 acres and may contain between 500,000 and 600,000 tons of material. The exact amount and potential uses are unknown.

Constraints to development of these deposits may include houses in the area, roads, a church, cemeteries and a greenhouse.

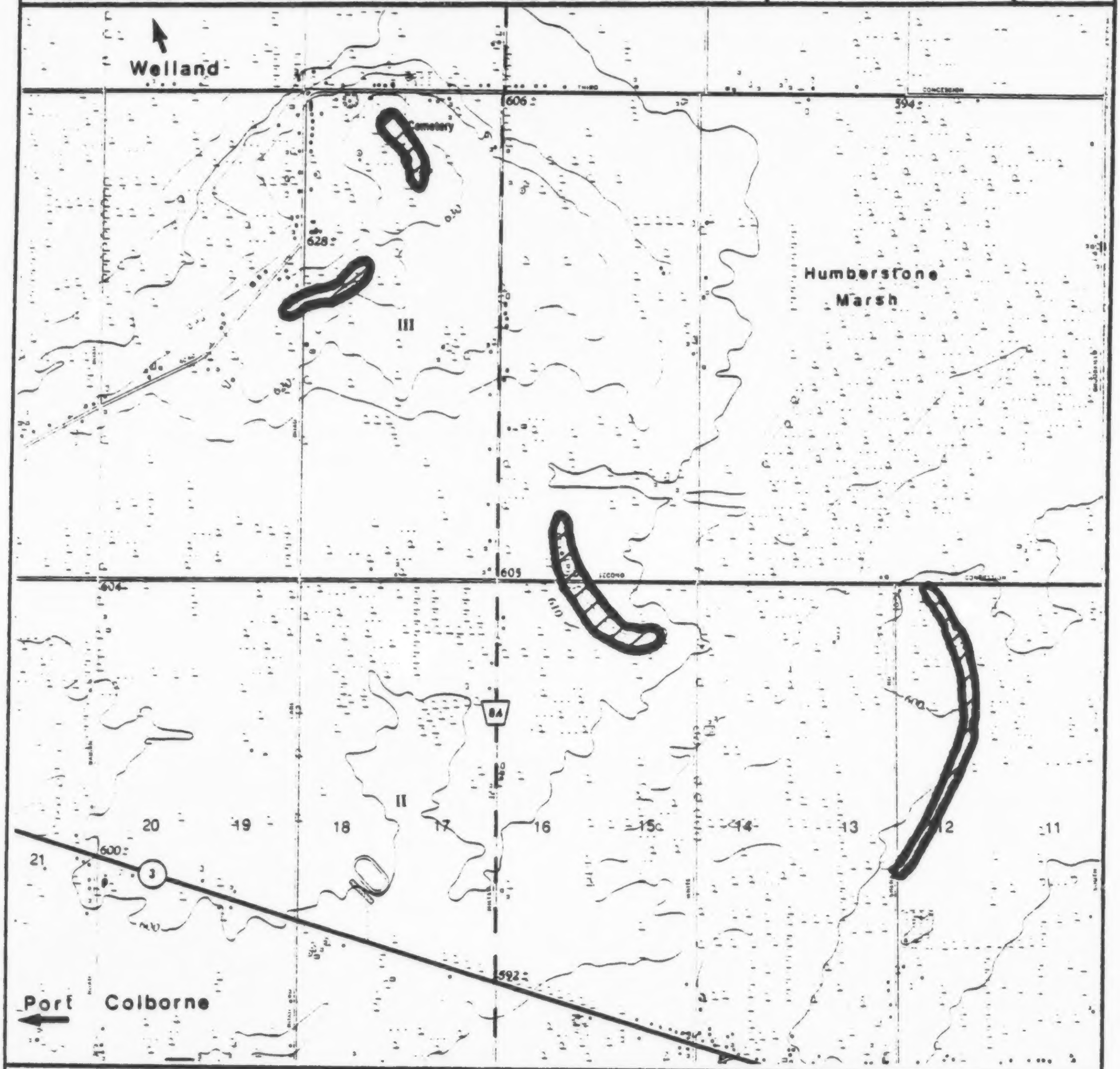
Note:

The dune deposits along Lake Erie are shown on Map 15b and described with other dune deposits.

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
PORT COLBORNE

22
SHEET NO


Welland
Cemetery
606
594
628
III
Humberstone Marsh
605
604
84
II
21
20
19
18
17
16
15
14
13
12
11
600
3
592
Port Colborne

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1:24,000 (1" : 2,000') (1cm : 240m)

Niagara

The Regional Municipality of Niagara
Planning and Development Department

April 1981

☐ 10 Acres Approx
(4 ha approx.)

N

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 22

Municipality Port Colborne

Four small deposits are located in the area southwest of the Humberstone Marsh. Geologically, they are described as glaciolacustrine beach/off-shore bar deposits of sand and gravel situated below the Onondaga Escarpment which is a bedrock formation. The deposits range from 3 to 7 feet in depth.

The deposits, excluding the existing development, cover about 27 acres and may contain between 250,000 and 350,000 tons of material. The exact amount and potential uses are unknown. However, some wayside pit activity may be possible.

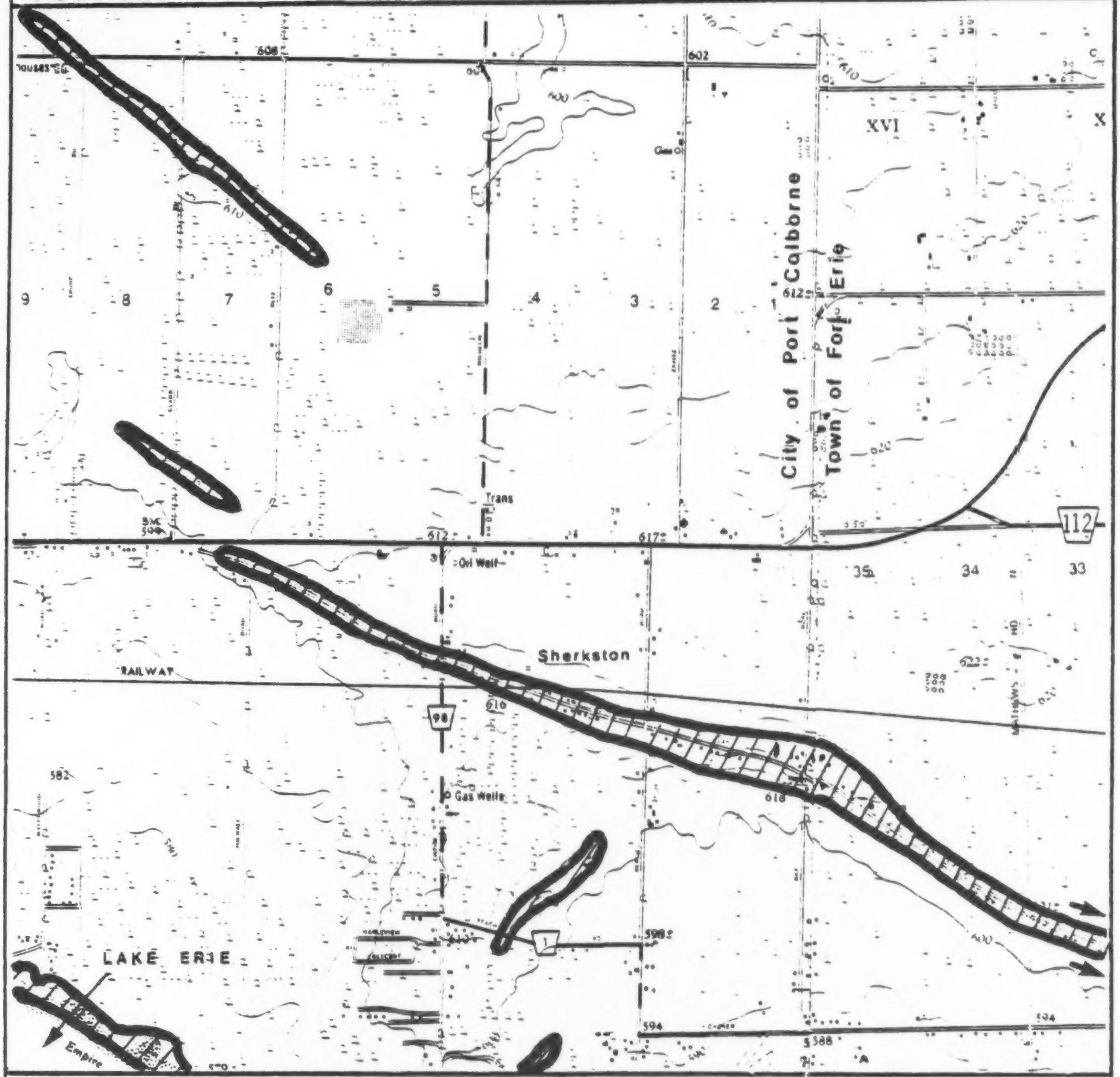
Constraints to development of these deposits may include houses in the area, roads, an intensive livestock operation and a cemetery.

NIAGARA SAND AND GRAVEL STUDY

POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
Port Colborne &
Fort Erie

23
SHEET NO



608
602
600
XVI
X
Gas Oil
610
9
8
7
6
5
4
3
2
612
City of Port Colborne
Town of Fort Erie
620
Trans
612
617
112
35
34
33
Oil Well
Sherkston
RAILWAY
622
98
610
582
Gas Wells
618
1
598
600
LAKE ERIE
Empire
594
588
594

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1 : 24,000 (1" = 2,000') (1cm = 240m)

FEET 1000 0 1000 2000 3000 4000

METRES 300 0 300 1000

April 1981

☐ 10 Acres Approx (4 ha approx.)

N

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 23

Municipality Port Colborne,
Fort Erie

Five linear, inland deposits are located in the vicinity of the Sherkston community. Geologically, they are described as a glaciolacustrine beach/off-shore bar deposits of gravelly sand situated on the Onondaga Escarpment, which is a bedrock formation. The longest of the five linear deposits which runs along Sherkston Road rests on top of the Crystal Beach Morraine. These deposits range from 3 to 5 feet in depth.

The deposits, excluding the existing development, cover about 45 acres and may contain between 350,000 and 450,000 tons of material. The exact amount and potential uses are unknown. However, some wayside pit activity may be possible.

Constraints to development of these deposits may include houses in the area, roads, commercial establishments and a private campground.

Note:

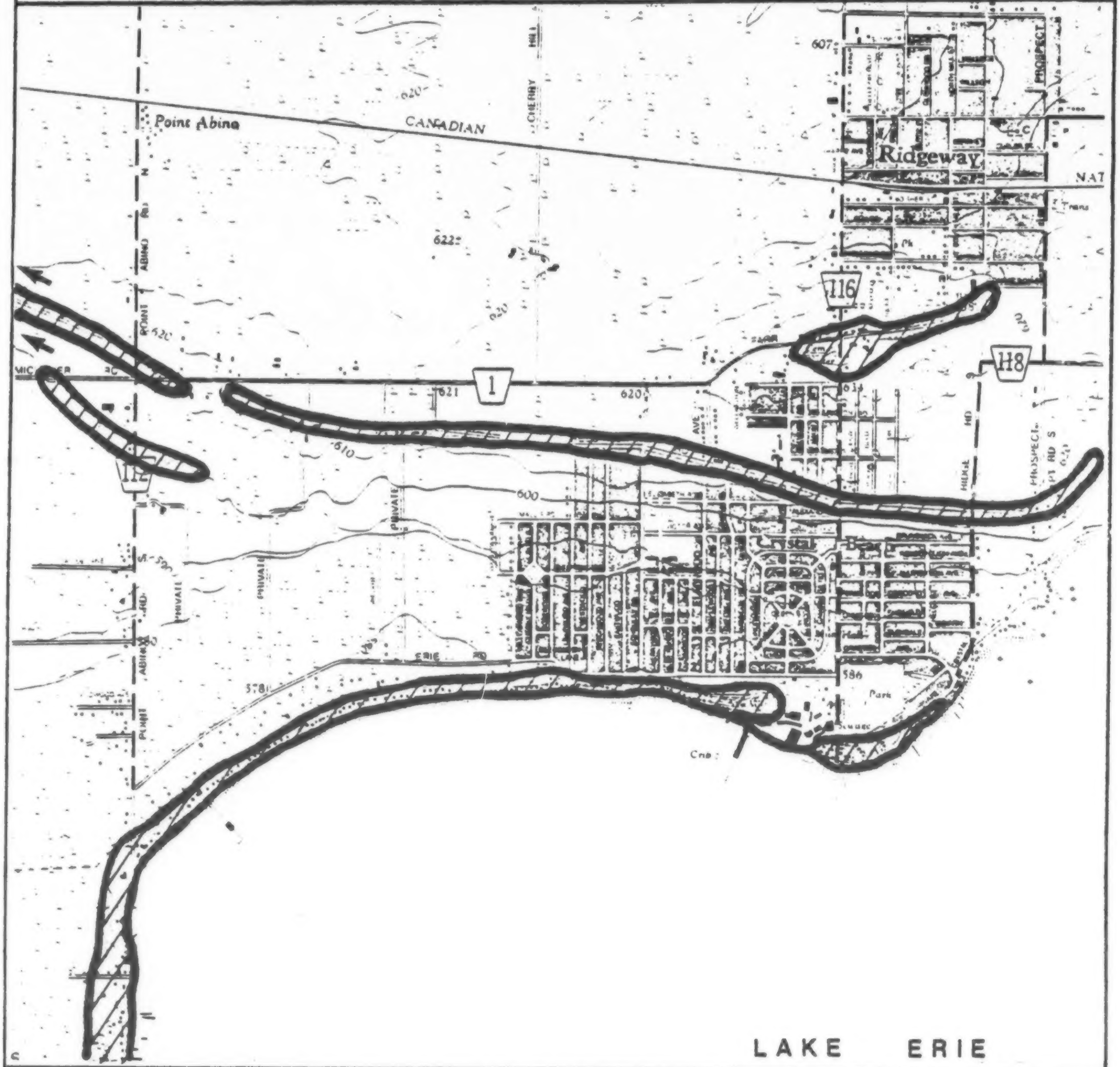
The dune deposits along Lake Erie are shown on Map 18 and described with other dune deposits.

NIAGARA SAND AND GRAVEL STUDY

POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
FORT ERIE

24
SHEET NO


Point Abino
CANADIAN
Ridgeway
NAT
CHERRY HILL
PROSPECT
620
622
621
610
600
578
586
607
116
118
1
112
POINT ABINO RD
PRIVATE
ERIE RD
Crystal Beach
Park
LAKE ERIE

Notes.

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

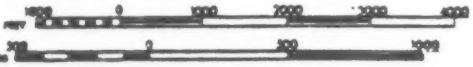
The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits ⚒

Possible Resource Areas ▨

SCALE 1 : 24,000 (1" = 2,000') (1cm : 240m)


1000
0
1000
2000
3000
4000
300
0
300
1200

April 1981

☐ 10 Acres Approx
(4 ha approx.)

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 24

Municipality Fort Erie

Excluding the Lake Erie dune deposits also shown on Maps 19 and 20 , four linear, inland deposits are located near the communities of Ridgeway and Crystal Beach. They are described as glaciolacustrine beach/off-shore bar deposits of gravelly sand, situated on the Onondaga Escarpment, which is a bedrock formation. The deposits are formed on top of the Crystal Beach Morraine and range from 3 to 10 feet in depth.

The deposits, excluding the existing development, cover about 30 acres and may contain between 250,000 and 350,000 tons of material. The exact amount and potential uses are unknown. However, some wayside pit activity may be possible.

Constraints to development of the smaller deposits may include houses in the area, roads and cemeteries. The major portion of the larger deposit in Crystal Beach is covered by urban development.

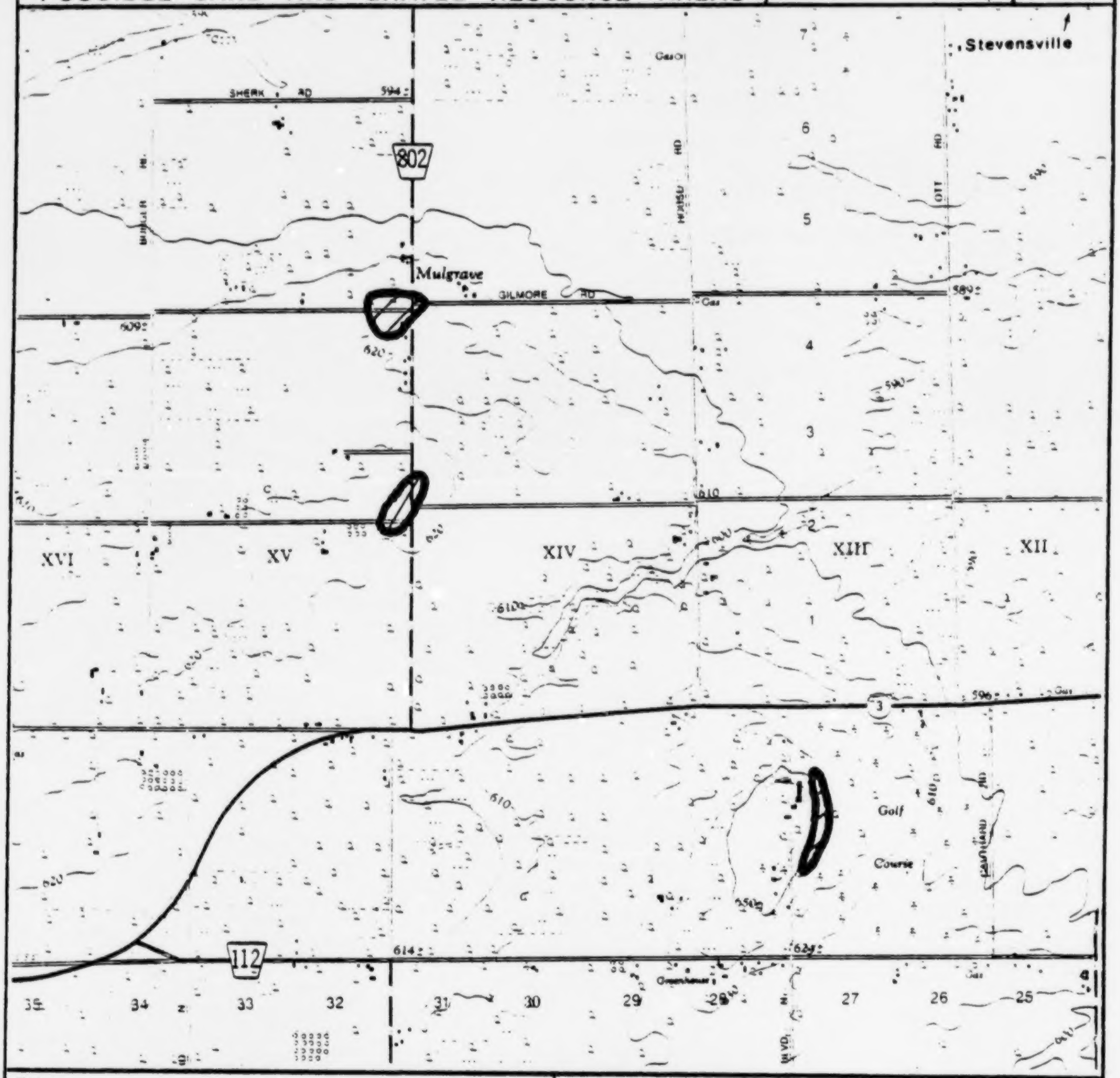
Note:

The dune deposits along Lake Erie are described with the other dune deposits and are shown on Maps 19 and 20.

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
FORT ERIE

25
SHEET NO


Stevensville
SHERK RD
594
802
Mulgrave
GILMORE RD
589
609
620
590
610
7
6
5
4
3
2
1
OTT RD
Gas
XVI
XV
XIV
XIII
XII
3
596
Golf
Course
650
112
614
624
Greenhouse
35
34
33
32
31
30
29
28
27
26
25

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1 : 24,000 (1" = 2,000') (1cm = 240m)

FEET 1000 0 1000 2000 3000 4000

METRES 500 0 500 1000

April 1981

□ 10 Acres Approx (4 ha approx.)

Niagara

The Regional Municipality of Niagara
Planning and Development Department

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 25

Municipality Fort Erie

Three small deposits are located southwest of Stevensville. They are glaciolacustrine beach/off-shore bar deposits of gravelly sand, situated on the edge of the Onondaga Escarpment and are about 3 feet in depth.

The deposits, excluding the existing development, cover about 10 acres and may contain between 50,000 and 100,000 tons of material. The exact amount and potential uses are unknown. However, some wayside pit activity may be possible.

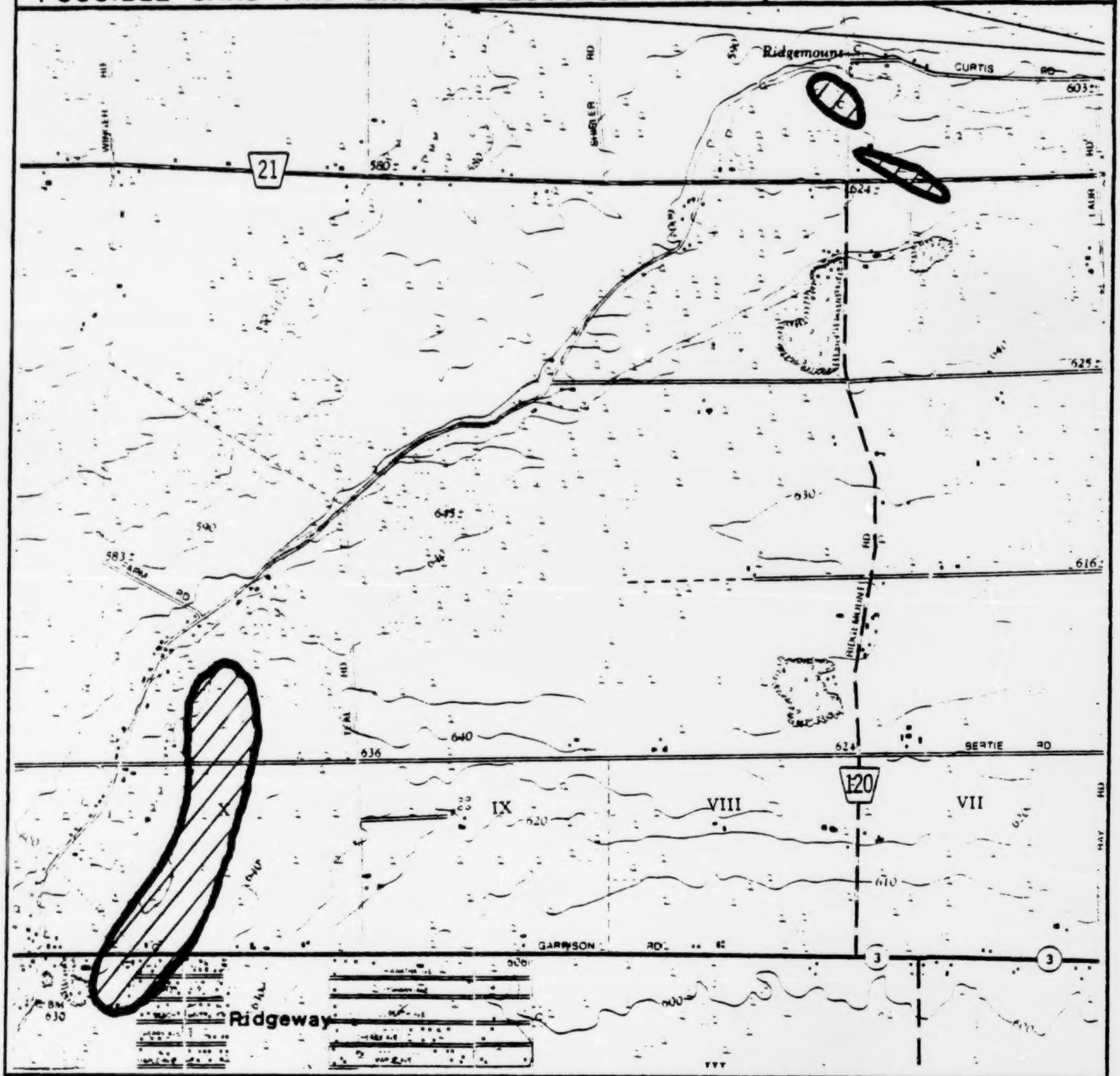
Constraints to development of these deposits may include houses in the area, roads and a golf course.

NIAGARA SAND AND GRAVEL STUDY

POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
FORT ERIE

26
SHEET NO


Ridgemount
CURTIS RD
603
21
580
624
625
630
645
590
583
RD
616
636
640
624
BERTIE RD
120
IX
VIII
VII
620
610
GARRISON RD
3
3
Ridgeway
600
BM
630

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits ⚒

Possible Resource Areas ▨

SCALE 1 : 24,000 (1" : 2,000') (1cm : 240m)

April 1981

☐ **10 Acres Approx**
(4 ha approx.)

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 26

Municipality Fort Erie

Three deposits are located southeast of Stevensville. Geologically, they are glaciolacustrine beach/off-shore bar deposits of sand and gravel, situated on the edge of the Onondaga Escarpment, which is a bedrock formation. The two deposits to the north are 3 feet in depth whereas the larger, southernmost deposit is 10 feet depth. The latter deposit has seen a small amount of extractive activity in the past.

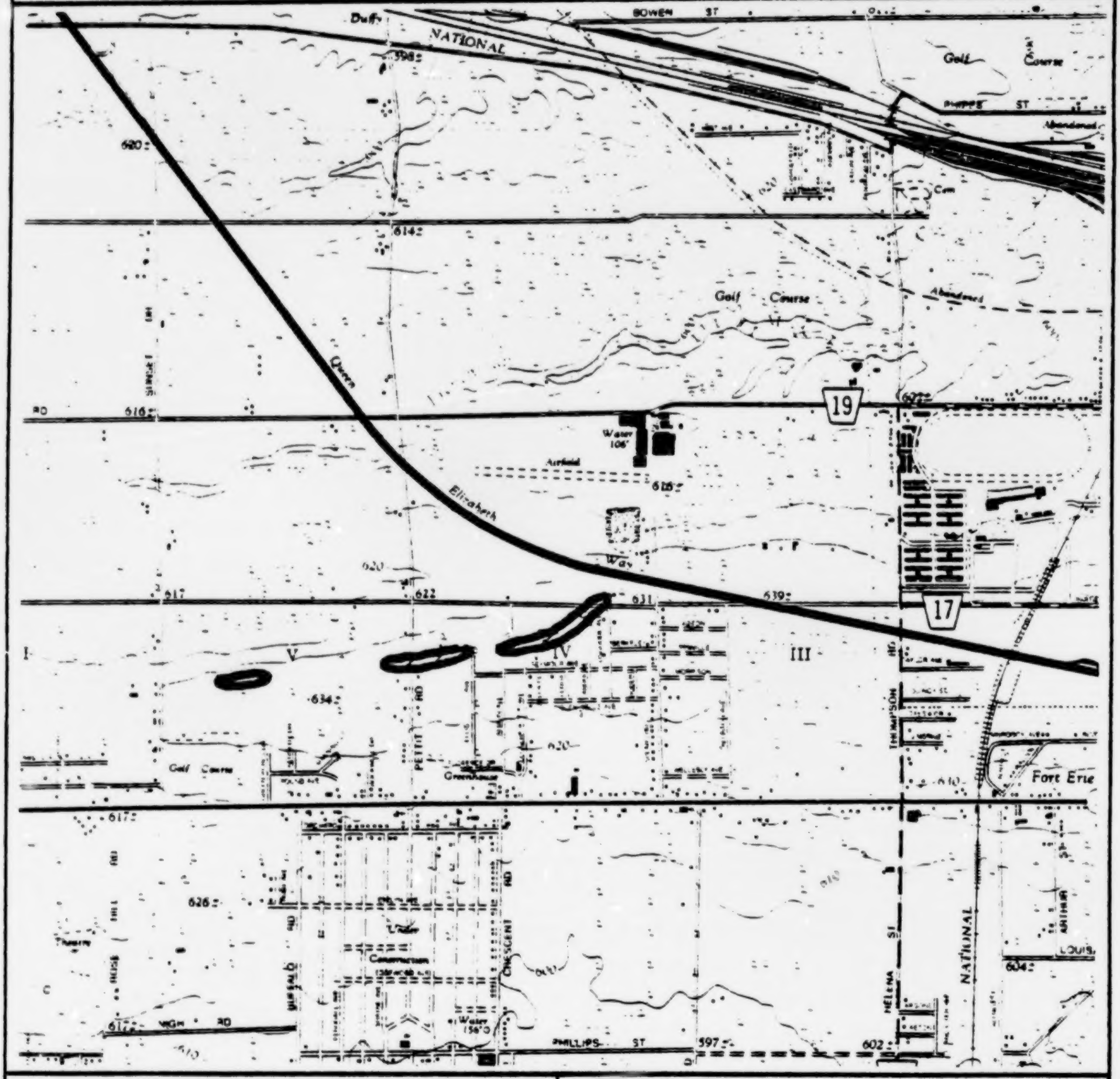
The deposits, excluding the existing development, cover about 67 acres and may contain between 1,500,000 and 1,600,000 tons of material. The exact amount and potential uses are unknown. However, some wayside pit activity may be possible.

Constraints to development of these deposits may include houses in the area, roads, a power transmission line, cemeteries and a historical burial vault/park area.

NIAGARA SAND AND GRAVEL STUDY
POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Municipality
FORT ERIE

27
SHEET NO


Duff
NATIONAL
BOWEN ST
Golf Course
PHIPPS ST
Abandoned
Cem
598
620
614
Golf Course
Abandoned
Queen
RD 616
19
Water 106'
Airfield
626
Elizabeth
Way
620
617
622
631
639
17
I
V
IV
III
634
PETIT RD
THOMPSON
620
Golf Course
Greenhouse
Fort Erie
610
617
626
Under Construction
Water 156'
CRESCENT RD
HELENA ST
NATIONAL
604
LOUIS
HIGH RD
PHILLIPS ST
597
602
600

Notes:

(1) Possible resource areas derived from preliminary field maps of the Ministry of Natural Resources.

(2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

(3) Maps and description prepared by Regional staff.

Possible resource area boundaries are not precise

Map base from Proctor & Redfern Ltd. topographic maps.

Niagara

The Regional Municipality of Niagara
Planning and Development Department

Legend

Licensed Sand and Gravel Pits	⚒
Possible Resource Areas	▨

SCALE 1 : 24,000 (1" = 2,000') (1cm = 240m)

April 1981

☐ 10 Acres Approx (4 ha approx.)

N

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet No. 27

Municipality Fort Erie

Three small deposits are located west of the Town of Fort Erie. Geologically, they are glaciolacustrine beach/off-shore bar deposits of sand and gravel, situated on the Onondaga Escarpment, which is a bedrock formation. These deposits which are about 3 feet in depth rest on top of the Fort Erie Morraine.

A golf course and urban development cover most of the resource areas therefore future extraction would be very limited.

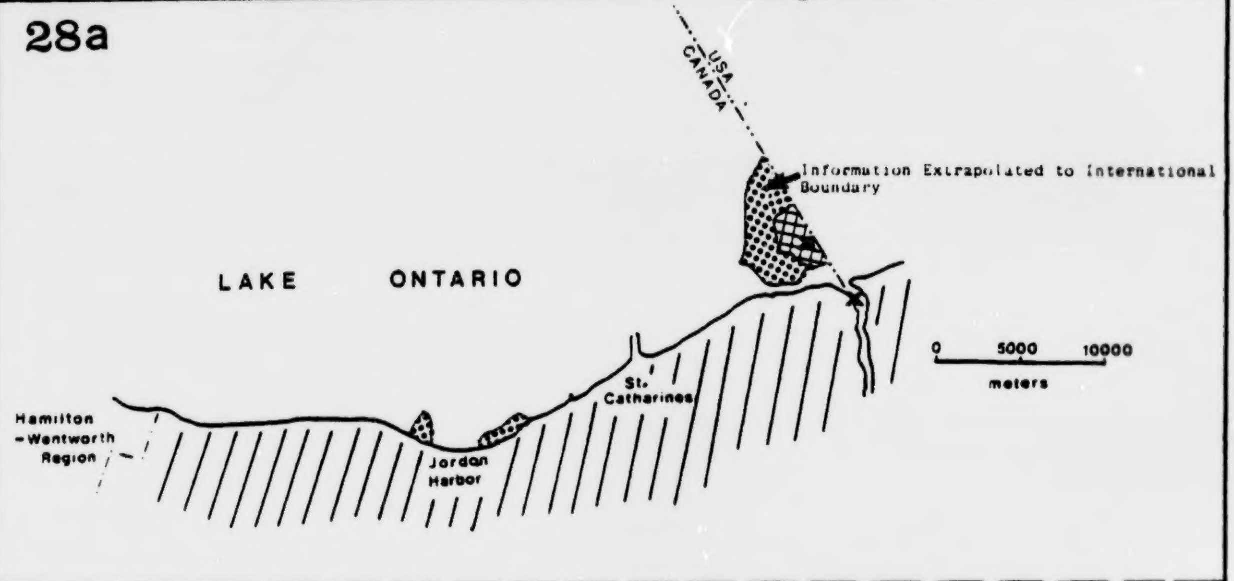
NIAGARA SAND AND GRAVEL STUDY

POSSIBLE SAND AND GRAVEL RESOURCE AREAS

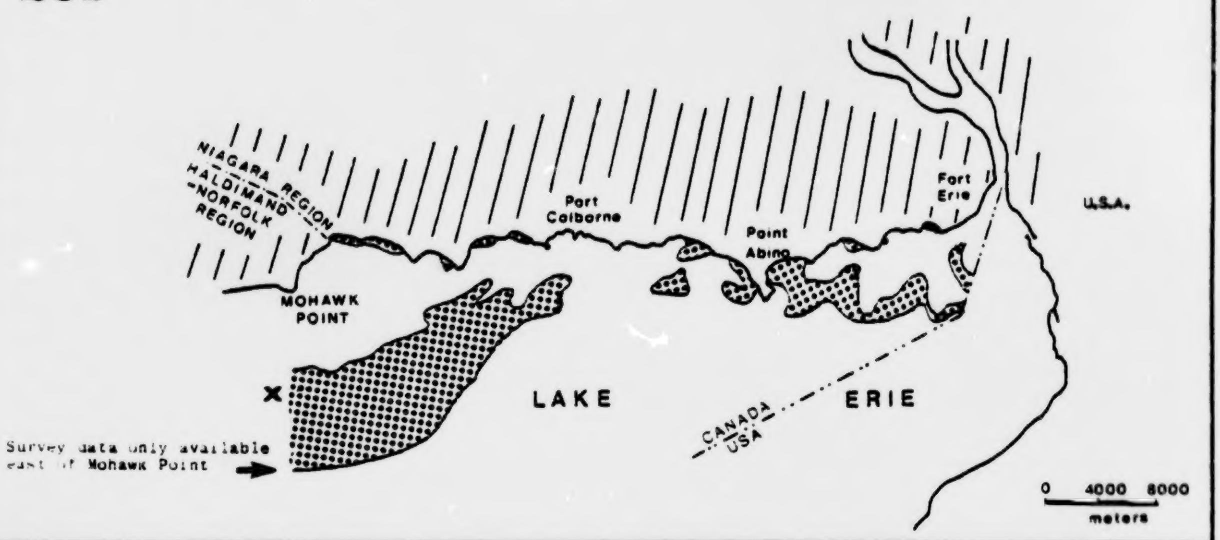
Lake Ontario, the Niagara River and Lake Erie

28
SHEET NO

28a


USA
CANADA
Information Extrapolated to International Boundary
LAKE ONTARIO
0 5000 10000
meters
St. Catharines
Hamilton -Wentworth Region
Jordan Harbor

28b


NIAGARA REGION
HALDIMAND -NORFOLK REGION
Port Colborne
Point Abino
Fort Erie
U.S.A.
MOHAWK POINT
x
LAKE ERIE
CANADA
USA
Survey data only available east of Mohawk Point
0 4000 8000
meters

Notes

1) Possible resource areas and base maps derived from N. A. Rukavina, 1969 (Canada Center for Inland Waters)

2) Licensed areas derived from site plans provided by the Ministry of Natural Resources.

3) Maps and descriptions prepared by Regional staff.

Possible resource area boundaries are not precise

LEGEND

Licensed Sand Dredging Areas x

Possible Resource Areas

sand ▒

gravel and pebbly sand ▨

April 1981

North

Niagara

The Regional Municipality of Niagara
Planning and Development Department

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet Nos. 28a and 28b

Location - Offshore deposits in Lake Ontario, Lake Erie and the Niagara River.

Nearshore survey data provided by the Canada Center for Inland Waters in Burlington (C.C.I.W.) indicates that deposits of sand and/or gravel in the vicinity of the Niagara Region are located in:

1) Lake Ontario near Jordan Harbour and at the mouth of the Niagara River (Map 28a).
2) The Niagara River adjacent to Fort George in the Town of Niagara-on-the-Lake (Map 28a) , and
3) Lake Erie at scattered locations between Fort Erie and Mohawk Point (Map 28b).

Little information seems to be available regarding the quantity and quality of these deposits but based on samples taken from these locations it appears that the deposits in Lake Ontario are coarser and are more suitable aggregates for a wider range of construction-grade materials than those found in Lake Erie. For example, the deposits dredged commercially at the mouth of the Niagara River are generally fine to medium-coarse sands with some gravel and can be made into concrete sands and brick or plaster-grade sands. Lake Erie deposits on the other hand (particularly those which are dredged from the area adjacent to Mohawk Point) contain clay, silt and finer sands which are generally used for fill purposes.

In Lake Ontario a small amount of fine sand has accumulated along the lakeshore near Jordan Harbour. The larger deposit (commonly termed the "Niagara Deposit") situated at the mouth of the Niagara River, contains greater quantities of sand, gravel and pebbly sand. This deposit extends out into Lake Ontario as a subaqueous delta covering about 20 square miles. It appears that a greater part of the deposit is situated in the United States rather than in Canadian territory. Part of this deposit is currently licensed for commercial dredging activities.

In 1969 the International Association for Great Lakes Research sponsored a study that included the Niagara Deposit and estimated that between 120 million and 180 million tons of sand and gravel are available at water depths not exceeding 50 feet. In general, the coarser sands and gravels are found closer to the Niagara River mouth with finer deposits occurring lakeward. The entire deposit

DESCRIPTION OF POSSIBLE SAND AND GRAVEL RESOURCE AREAS

Inventory Sheet Nos. 28a and 28b
(Page 2)

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appears to be relatively thin, probably not exceeding 33 feet in thickness with an average of about 16 feet. The material present originated from the Niagara River particularly after the glacial period, and has been further transformed by eastward-moving longshore currents in Lake Ontario.

A nearshore sediment study published by the C.C.I.W. in March, 1981 appears to verify the qualitative data described in the study noted above but also makes some comment on the ability of the deposit to replenish itself. One sample analysis indicated that over a 123 year period only about 15 inches of material had accummulated representing a rate of 0.12 inches per year. It was also noted however that this may not necessarily be representative of accummulation rates for Niagara Bar sediments in general.

Some concern has been raised about the ability of the Niagara deposit to trap waste materials including heavy metals. Discussions held with the Aquatic Ecology Division of the C.C.I.W. indicate that these types of materials would likely be trapped in the clay and silt materials which are located on the outer, deeper portions of the deposit. Gravel and pebbly sand materials closer to the river mouth would trap lesser amounts of these wastes.

Sand deposits in Lake Erie (Map 28b) have been derived by lake bottom erosion and transported by eastward moving, longshore currents. The sands in the area between Port Colborne and Mohawk Point appear to be coarser-grained and thinner than sands situated in areas toward Fort Erie. These materials furthermore, are well-sorted and are fairly thin deposits (about 4 to 12 inches).

The longshore currents have deposited some sediment on the upcurrent side of the shoreline and have eroded the down-current side. This is evident in Map 28b.

Appendix 5

USERS GUIDE TO CONSTRUCTION AGGREGATE

A USER'S GUIDE TO CONSTRUCTION AGGREGATES

The Aggregate Producers' Association of Ontario was founded in 1956 and represents the majority of the producers of one of the most essential ingredients for all forms of construction.

With the continuing growth of the Province, there is a consequent ever increasing demand for construction aggregates to meet a wide range of specifications.

In the interests of both supplier and consumer, this Guide has been prepared with the object of establishing standard specifications and definitions of materials to replace the variety of terminology which has previously existed.

Revised and updated in consultation with the Ontario Ministry of Transportation and Communications

FOREWORD

The rapid growth of the industry and the ever increasing demand for aggregates has led to a proliferation in terminology and specifications by producers and end users large and small.

Terminology often pre-dates the advent of modern production methods and has become confusing and far from descriptive of the product. This, in turn, has led to an unnecessary multiplicity of sizes and gradations, almost identical, yet insisted upon by the user for want of uniform nomenclature.

The Aggregate Producers' Association of Ontario in consultation with the Ontario Government, Ministry of Transportation and Communications, carried out an extensive study into the most widely used aggregates. It has been able to classify and clarify the many products into a Guide which will enable the user to select the correct aggregate and be sure that it is available from stock. Other sizes and gradations for special requirements can generally be made available on request and will normally incur an additional charge.

No attempt has been made to deal with the physical properties of the aggregates. Reference has been made to the most widely used and accepted specifications in each group.

The contents are arranged so that the reader can refer to the particular group of aggregates and to a summary table for quick reference.

The Guide introduces for the first time an identification for each product. It is hoped that the terminology will be generally accepted and thus simplify the specifying and ordering of aggregate. **Nominal** size referred to throughout this manual shall be the smallest screen size through which 100 per cent of the material may pass.

A quarry is a mining operating for obtaining material for construction, industrial or manufacturing purposes, from CONSOLIDATED deposits of limestone, granite, traprock and other rock types by means of drilling, blasting, crushing and screening.

A sand and gravel pit is an open pit mining operation for obtaining materials for construction, industrial or manufacturing purposes, from UNCONSOLIDATED deposits of clastic materials derived from weathered limestone, granite and other rock types: sand and gravel may be used in their natural form or processed by means of crushing screening and/or washing and classifying.

Slag, in general, can be defined as the non-metallic material produced simultaneously with molten metal when metallic ores or their derivatives are chemically reduced by means of the smelting process. In Ontario three different types of slag are commercially available for construction usage: 1. Iron Blast Furnace Slag, 2. Steel Slag, 3. Nickel Slag.

NOTE

The A.P.A.O. continues to work closely with M.T.C. in reviewing and revising aggregate specifications. A review of product specifications is currently underway, however, the following are the accepted specifications as of January 20th, 1980. All concerned will be notified of any changes or modifications of M.T.C. specifications.

THIRD METRIC EDITION: JANUARY 1980
AGGREGATE PRODUCERS' ASSOCIATION OF ONTARIO

NOTE: $1\mu = 1$ micrometre $= \frac{1}{1000}$ millimetre (mm)

GROUP 1: GRANULAR BASE AND SUBBASE

1.1 Granular Base and Subbase material may be defined as a dense graded non-cohesive mineral aggregate, normally specified and identified in terms of the nominal size of the material and processed by crushing and by screening or blending suitably graded materials to conform to the gradation requirements and standards of quality as outlined in 1.3 and 1.4 respectively. In the case of Granular "B" and Granular "C" processing may not be necessary to meet these requirements.

1.2 Source material may be: (i) quarried rock, (ii) sand and gravel deposits, (iii) iron, steel or nickel slags.

1.3 **AGGREGATE GRADATION LIMITS**

Sieve Size	PERCENT PASSING						
			38 mm Crushed	19 mm Crushed	16 mm Crushed		4.75 mm Crushed
	Granular "C"	Granular "B"	Granular	Granular "A"	Type "A"	Type "B"	Granular "D"
152 mm	100						
106 mm		100					
53 mm			100				
26.5 mm	50-100						
22.4 mm		57-100		100			
19 mm			50-75				
16 mm				75-100	100	100	
13.2 mm				65-90	75-95	75-95	
9.5 mm			40-65		50-80	50-80	100
4.75 mm (No. 4)	20-100	25-100	30-50	35-55	25-50	25-50	50-100
1.18 mm (No. 16)	10-100	10-85		15-45	10-40	10-40	20-55
600 µm (No. 30)			10-30				
300 µm (No. 50)	5-90	5-40		5-22	2-20	2-20	10-30
150 µm (No. 100)	4-30				0-10	2-13	
75 µm (No. 200)	0-10	0-8	3-8	0-8	0-5	0-8	0-12
53 µm (No. 270)	0-5						
M.T.C. Spec. No.	1010	1010		1010	1010 and 304, Class 2	1010	1010

1.4 **AGGREGATE QUALITY**

1.4.1 Refer to current M.T.C. Specifications for all products listed.

1.5 **Special Notes**

1.5.1 Material meeting the above aggregate gradations complies with the requirements of M.T.C.

1.5.2 Variations in aggregate gradations limits are permitted. The allowable tolerances are as detailed in the appropriate specification.

1.5.3 16 mm Crushed, Type "A" is similar to, and may be used for, "Surface Treatment" Aggregate, Class 2 M.T.C. 304.

GROUP 2:
COARSE
AGGREGATE

2.1 Coarse aggregate is a well-graded construction aggregate, graded between defined maximum and minimum allowable sizes specified and identified in terms of the nominal size of the material and processed by means of crushing and/or screening, and washing as necessary, to conform to the product type and gradation requirements and standards of quality outlined in 2.3 and 2.4.

2.2 Source material may be: (i) quarried rock, (ii) sand-gravel deposits, (iii) iron, steel or nickel slags.

2.3 AGGREGATE GRADATION LIMITS

Sieve Size	PERCENTAGE PASSING								
	PORTLAND CEMENT CONCRETE				ASPHALTIC CONCRETE			SURFACE TREATMENT	ROOFING
	37.5 mm —No. 4	19 mm —No. 4	13.2 mm —No. 4	9.5 mm —No. 8	HL1 HL3	HL4 HL5	HL6 HL8	CLASS 1	
53 mm	100								
37.5 mm	95-100								
26.5 mm		100					100		
19 mm	35-70	90-100	100	–			90-100		100
16 mm		65-90				100	65-90		
13.2 mm			90-100	100	100	70-88		100	90-100
9.5 mm	10-30	20-55	40-70	85-100	50-73	30-52	20-55	75-100	40-70
6.7 mm								0-40	
4.75 mm (No. 4)	0-5	0-10	0-15	10-30	0-10	0-10	0-10	0-10	0-15
2.36 mm (No. 8)		0-5	0-5	0-10					0-5
1.18 mm (No. 16)				0-5					
Spec. Ref.	CSA A23.1 and MTC 1002				MTC 1083	MTC 303		MTC 304	ASTM D. 1863

2.4 AGGREGATE QUALITY

2.4.1 Portland Cement Concrete – refer to current C.S.A. Standard A23.1 and MTC Spec. 1002.
2.4.2 Asphaltic concrete – refer to MTC specification 1003.
2.4.3 Surface-treatment – refer to MTC specifications 303 and 304.
2.4.4 Roofing – refer to ASTM D. 1863.

2.5 Special Notes:

2.5.1 HL designates hot mix, hot-laid asphaltic concrete aggregate.

2.5.2 HL1 designates M.T.C. approved commercial trap rock source.

2.5.3 HL3, HL5, HL6, designates M.T.C. approved commercial aggregate source.

2.5.4 37.5 mm — No. 4 nominal size concrete is frequently supplied in two separate sizes in order to minimize segregation, i.e. 37.5—19mm (ref 4.3) nominal size and 19 mm—No. 4 nominal size. The two aggregates are blended at the concrete plant facility to conform to the 37.5 mm—No. 4 specification requirement.

2.5.5 Steel slag is unsuitable for use for portland cement concrete aggregate. However it may be used for other aggregate purposes.

2.5.6 HL4, HL5 coarse aggregate is similar to, and may be used for "Prime and Double Surface Treatment" coarse aggregate MTC 303.

GROUP 3: FINE AGGREGATE

3.1 Fine aggregate is a construction aggregate processed by screening only, by crushing and screening, by air or water classification, or by blending suitably graded materials resulting from these processes to conform to the product type and the gradation requirements and standards of quality outlined in 3.3 and 3.4 respectively.

3.2 Source material may be: (i) quarried rock, (ii) sand-gravel deposits, (iii) iron, steel or nickel slags.

3.3 **AGGREGATE GRADATION LIMITS:**

Sieve Size	PERCENTAGE PASSING							
	PORTLAND CEMENT CONCRETE	CONCRETE BLOCK	MASONRY MORTAR	ASPHALTIC CONCRETE			SURFACE TREAT-MENT CLASS 3	ICE CONTROL
				HL1, HL3	HL2	HL4, HL5, HL6, HL8		
13.2 mm		100						
9.5 mm	100	95-100			100		100	
6.7 mm								100
4.75 mm (No. 4)	95-100	65-85		100	85-100	100	85-100	
2.36 mm (No. 8)	80-100	45-70	100	80-100	70-90	70-100	55-100	65-95
1.18 mm (No. 16)	50-85	30-55		55-90	50-75	40-90	30-90	40-90
600 µm (No. 30)	25-60	15-40		35-70	30-55	20-70	15-70	20-70
300 µm (No. 50)	10-30	8-25	15-40	15-40	15-35	10-40	5-40	5-35
150 µm (No. 100)	2-10	0-15	0-10	5-15	5-16	3-15	0-15	0-15
75 µm (No. 200)	0-3 Natural 0-5 Manufactured		0-5	0-5	3-8	0-7	0-7	0-5
FM	2.3-3.1		1.6-2.5					
Spec. Ref.	CSA A23.1		C.S.A. A82.56		MTC 306		MTC 303 and 304	MTC 414
				MTC 1003				

3.4 **AGGREGATE QUALITY:**

3.4.1 Portland Cement concrete – refer to current C.S.A Standard A23.1.

3.4.2 Asphaltic concrete – refer to current M.T.C. specification 1003.

3.4.3 Surface Treatment – refer to MTC specifications 303 and 304.

3.4.4 Ice Control – refer to MTC specification 414.

3.5 **Special Notes:**

3.5.1 HL2 aggregate gradation is identical to "Dense Graded Thin Bituminous Hot-Mix Surfacing" M.T.C. Form 306.

3.4.2 Variations in aggregate gradation limits are permitted. The allowable tolerances are as detailed in the appropriate specification.

GROUP 4: CLEAR AGGREGATE

4.1 Clear aggregate is a predominatly one-size construction aggregate, graded between defined maximum and minimum allowable sizes: specified and identified in terms of the nominal size of the material and processed by means of crushing and/or screening, and washing as necessary, to meet the specific requirements.

4.2 Source material may be: (i) quarried rock, (ii) sand-gravel deposits, (iii) iron, steel or nickel slags.

4.3 **AGGREGATE GRADATION LIMITS:**

Sieve Size	PERCENTAGE PASSING		
	Nominal size		Ballast
	37.5 mm CLEAR	19 mm CLEAR	
53 mm	100		
37.5 mm	90-100		
26.5 mm	20-55	100	
19 mm	0-15	75-100	Refer to appropriate specifying authority
13.2 mm		0-15	
9.5 mm	0-5		

4.4 **AGGREGATE QUALITY:**

Refer to specifying authority.

GROUP 5: SPECIAL APPLICATION PRODUCTS:

5.1 **Armour Stone** is a stone in excess of 1 tonne and up to approximately 10 tonnes. This is obtained from the face of a quarry after blasting. Size depends on depth of bed and drilling pattern.

5.2 **Rubble** (face rock) is that material obtained from the face of a quarry after armour stone is removed. Size is dependent upon drilling pattern and will not necessarily be the same from one quarry to another. Rubble is very irregular in shape and size.

5.3 **Select Rubble** is that stone removed by shovel or loader taking particular care to have as little fines as possible.

5.4 **Rip-Rap** is a term to describe stones of various sizes from 305-508 mm which may be hand laid or machine laid on an embankment slope to prevent erosion. Spalls (smaller sized stones) or mortar may be used to fill in open joints. Reference: M.T.C. Form No. 424.

5.5 **Gabion Stone** ranges from 76-305 mm coming in various combinations, e.g. 106-152 mm, 178-305 mm. This material is often set in gabion baskets (wire mesh) and then placed upon another for slope stabilization and erosion control.

5.6 **Mineral Filler** consists of thoroughly dry limestone or other mineral powder conforming to the requirements of the appropriate specifying authority.

5.7 **Pit Run** is an unprocessed material obtained from deposits of sand or gravel, talus rock, quarries, slag, mine waste, clinkers or other suitable granular materials.

5.8 **Slurry Seal Aggregate** is the mineral component of the slurry seal process for pavement surface restoration.

5.9 **Interior Plaster Aggregate** consists of finely graded mineral components of perlite, vermiculite or sand comforming to CSA Standard A82.57 - 1954.

SPECIFICATIONS

Of the many specifications which describe the products listed in groups 1 to 4, the following are those which are normally used in Ontario.

Group 1 — Granular Base and Subbase

M.T.C. Form 1010 — Aggregate — Granular Base and Sub-base

Group 2 — Coarse Aggregate

Portland Cement Concrete

C.S.A. Standard A23.1 — Concrete Materials & Methods of Concrete Construction
M.T.C. Form 1002 — Aggregates — Concrete
A.S.T.M. C33 — Specification for Concrete Aggregates

Asphaltic Concrete

M.T.C. Form 1003 — Aggregates Hot-Mix Asphaltic Concrete

Surface Treatment

M.T.C. Form 303 — Prime and Double Surface Treatment
M.T.C. Form 304 — Surface Treatment with Bituminous Material

Roofing Aggregate

A.S.T.M. D 1863 — Mineral Aggregate for Use on Built-up Roofs

Group 3 — Fine Aggregate

Portland Cement Concrete

C.S.A. Standard A23.1 — Concrete Material & Methods of Concrete Construction
M.T.C. Form 1002 — Aggregate — Concrete
A.S.T.M.C33 — Specification for Concrete aggregates

Masonry Mortar

C.S.A. Standard A82.56 — Aggregate for Masonry Mortar

Asphaltic Concrete

M.T.C. Form 1003 — Aggregates — Hot-Mix Asphaltic Concrete
M.T.C. Form 306 — Dense Graded Thin Bituminous Hot-Mix Surfacing

Ice Control

M.T.C. Form 414 — Specification for Ice Control

Group 4 — Clear Aggregate

Ballast

C.N.R. — Ballast specifications
C.P.R. — Ballast specifications
A.R.E.A. — Ballast specifications

ABBREVIATIONS

M.T.C. — **Ministry of Transportation & Communications (Ontario)**

C.S.A. — **Canadian Standards Association**

A.S.T.M. — **American Society for Testing & Materials**

A.R.E.A. — **American Railway Engineering Association**

INDEX OF RECOMMENDED USES OF AGGREGATES

MATERIAL	USES																	REMARKS
	1 FOUNDATION BACKFILL	2 TRENCH BACKFILL	3 ROAD SUBBASE	4 ROAD BASE	5 STABILIZED BASE COURSE	5 UNTREATED ROAD SURFACE	7 CONCRETE AGGREGATE	8 ASPHALT SURFACE COURSE	9 ASPHALT BINDER COURSE	10 PARKING LOT SUBBASE	11 PARKING LOT BASE	12 WEEPING TILE BEDDING SEWER BEDDING	13 BASE FOR CONCRETE FLOORS & SLABS	14 RAILROAD BALLAST	15 EROSION CONTROL	16 SURFACE TREATMENT	17 OTHER	
GROUP 1 - GRANULAR BASE & SUB BASE																		
GRANULAR "C"	X	X	X							X								
GRANULAR "B"	X	X	X							X								
37.5 mm CRUSHED GRANULAR		X	X	X	X						X		X					
19 mm CRUSHED (GRANULAR "A")		X		X	X	X					X		X					
16 mm CRUSHED (TYPE "A")																X	X	MULCH
16 mm CRUSHED (TYPE "B")						X											X	SHOULDERING, MAINTENANCE
4.75 mm CRUSHED (GRANULAR "D") (SCREENINGS)	X	X	X	X	X					X	X		X					
GROUP 2 - COARSE AGGREGATE																		
37.5 mm - No. 4 PORTLAND CEMENT CONCRETE							X											PAVEMENT OR MASS CONCRETE POURS
19 mm - No. 4 PORTLAND CEMENT CONCRETE							X							X				CNR "B" BALLAST CPR NO. 5 BALLAST STRUCTURAL CONCRETE
13.2 mm - No. 4 PORTLAND CEMENT CONCRETE							X											THIN SECTION CONCRETE
9.5 mm - No. 4 PORTLAND CEMENT CONCRETE							X											THIN SECTION CONCRETE
HL1 ASPHALTIC CONCRETE								X										HIGH DENSITY TRAFFIC
HL3 ASPHALTIC CONCRETE								X										MEDIUM DENSITY TRAFFIC
HL4, HL5 ASPHALTIC CONCRETE								X	X							X		
HL6, HL8 ASPHALTIC CONCRETE									X									
SURFACE TREATMENT																	X	BITUMINOUS SURFACE TREATMENT FOR ROADS
ROOFING																	X	AGGREGATE FOR BUILT UP ROOFING
GROUP 3 - FINE AGGREGATE																		
PORTLAND CEMENT CONCRETE							X											
CONCRETE BLOCK																	X	BLENDED AGGREGATE FOR CONCRETE BLOCK
MASONRY MORTAR																	X	SAND FOR MORTAR FOR MASONRY CONSTRUCTION
HL1, HL3 ASPHALTIC CONCRETE								X										
HL2 ASPHALTIC CONCRETE								X	X									
HL4, HL5 ASPHALTIC CONCRETE								X	X									
HL6, HL8 ASPHALTIC CONCRETE									X									
ICE CONTROL																	X	AGGREGATE FOR ICE CONTROL ON ROADS
SURFACE TREATMENT																X		
GROUP 4 - CLEAR AGGREGATE																		
37.5 mm CLEAR												X	X	X				CNR "A" BALLAST, CPR NO. 4 BALLAST
19 mm CLEAR												X	X					
GROUP 5 - SPECIAL APPLICATION PRODUCTS																		
ARMOUR STONE															X			
RUBBLE															X			
SELECT RUBBLE															X			
RIP-RAP															X			
GABION STONE															X			
MINERAL FILLER								X	X									
PIT RUN	X	X	X							X					X			
SLURRY SEAL AGGREGATE																	X	SURFACE RESTORATION
INTERIOR PLASTER AGGREGATE																	X	FINE AGGREGATES FOR INTERIOR SURFACES